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Readers are invited to send in their comments and discussion of articles published in *Soviet Geography*. Readers are also encouraged to submit suggestions as to published Soviet geographic literature worthy of translation. Such suggestions should relate to articles of general substantive or methodological interest rather than materials of narrow, specialized appeal.

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TRANSLITERATION TABLE

Russian			English	Russian			English
А	а	*а*	a	Р	р	*р*	r
Б	б	*б*	b	С	с	*с*	s
В	в	*в*	v	Т	т	*т*	t
Г	г	*г*	g	У	у	*у*	u
Д	д	*д*	d	Ф	ф	*ф*	f
Е	е	*е*	e*	Х	х	*х*	kh
Ж	ж	*ж*	zh	Ц	ц	*ц*	ts
З	з	*з*	z	Ч	ч	*ч*	ch
И	и	*и*	i	Ш	ш	*ш*	sh
Й	й	*й*	y	Щ	щ	*щ*	shch
К	к	*к*	k	Ъ	ъ	*ъ*	"
Л	л	*л*	l	Ы	ы	*ы*	y
М	м	*м*	m	Ь	ь	*ь*	'
Н	н	*н*	n	Э	э	*э*	e
О	о	*о*	o	Ю	ю	*ю*	yu
П	п	*п*	p	Я	я	*я*	ya

(*) Instead of e, use ye at the beginning of names, after vowels and after the soft sign (').

The transliteration table is supplied for the general information of readers and to enable them to identify the geographic names on maps that will be reproduced from time to time in SOVIET GEOGRAPHY.

The transliteration system is the one proposed by the United States Board on Geographic Names. For more general use in textbooks and other popular needs, the following simplifications are recommended by the editor of SOVIET GEOGRAPHY:

1. Eliminate the use of (') and (").
2. Use i for iy, and y for yy.
3. Convert diphthongs ay, ey, oy, uy to ai, ei, oi, ui.

THIRD CONGRESS OF THE GEOGRAPHICAL SOCIETY OF THE USSR

FIELDS OF APPLICATION OF MODERN PHYSICAL AND CHEMICAL METHODS TO THE STUDY OF THE LANDSCAPE ENVELOPE OF THE EARTH

By M. M. Yermolayev

1.

The papers by S. V. Kalesnik and A. G. Isachenko (Soviet Geography, February 1961) deal with the basic factors of the development of modern landscape science and its theoretical-perceptual significance, its role in practical geography (especially in the evaluation of lands), as well as with the methods of landscape mapping.

In the present paper, we will attempt to clarify certain particular problems of this division of geography and point out possibilities of solving them by applying new physical and chemical methods. It should not be thought that this introduction of new methods into geography is aimed at replacing the old methods or that their appearance renders valueless and superfluous the usual modes of geographic perception of the earth's surface and the phenomena prevailing upon it. On the contrary, these new methods of research supplement the former complex, and they can and should be applied as auxiliary to the usual methods. Furthermore, their application makes it possible to broaden the tasks of studying the geographic environment and to pose new theoretical and practical geographic problems.

It appears to us that in modern geography the new methods will find wide application in the solution of two important problems of landscape science: in the study of the dynamics (and consequently the history) of the development of the landscape and in determining the complex relations between its components. The former requires no special clarification; the latter does. By complex relations we mean those forms of interaction in which two components interact, not through their direct influence upon one another but through the medium of a third (or several) intermediate components, which are, as it were, a transmission link between the constituent parts under study.

Such, for example, is the interaction between the biosphere and the lithosphere, effected through the soils, which in this case perform the role of an intermediate component. An example of a more subtle relationship is the distribution of large provinces of goiter diseases according to the distribution of the paths of cyclones, regions of monsoon circulation and high-pressure areas. In this case the intermediate agents are the masses of marine air bearing the iodine necessary for the normal activity of the human organism.

Examining a number of such examples, one may arrive at one general

conclusion: in studying the dynamics of the landscape, physical methods may have the greatest application, inasmuch as they make it possible to study the process of the change of state, i.e., movement in the broad sense of the word. On the other hand, to study complex relations it is more advisable to apply chemical methods, since they throw more light on the mode of distribution of a substance by individual components.

2.

Change in landscapes and their components in the course of time should be viewed from two aspects: with respect to the direction of change and from the viewpoint of the rate of change.

The former is usually determined by a complex of external, purely "geographic" features. The latter requires a more careful analysis. Thus, for example, in flights over the northern part of Arkhangel'sk Oblast it is possible to observe two positions of the boundary between forests and upland swamps on the watersheds between large streams. In some cases that boundary is so situated that the strip of deadwood is found to be within the young forest; in others, the young hem is rather far from reaching to the boundary of the deadwood, which in this case projects into the swamp. In the first case, we deal with an advance of the forest upon the swamp; in the second, with its retreat. More complicated is the determination of the rate of shift of the forest boundary. It requires a knowledge of the time that has elapsed since the beginning of the change in the position of the forest boundary until the moment of observation.

In the general case for the solution of this question, modern physical methods of determining age may come to the aid of the landscape scientist. These methods can be subdivided into two large groups. Some of them are universal, general for the whole world, in the widest sense of the word. They are founded on a study of the distribution of the products of the radioactive decay of uranium, thorium, actinium, potassium, samarium and other elements created long before the present geographic environment was formed. This group of methods may be called "geologic," inasmuch as they are widely applied in determining the age of rocks and geological events. For the geographer they have no special significance, and therefore we do not dwell upon them.

The second group of radioactive processes may rightly be called "geographic," since they are the result of the interaction between cosmic and telluric, i.e., purely terrestrial, phenomena and the nuclear reactions engendering them may occur only under specific circumstances of the terrestrial geographic environment.

To understand this, let us examine one of such phenomena, which occur in the upper layers of the earth's atmosphere.

As is known, a mass of diverse particles possessing high energy come

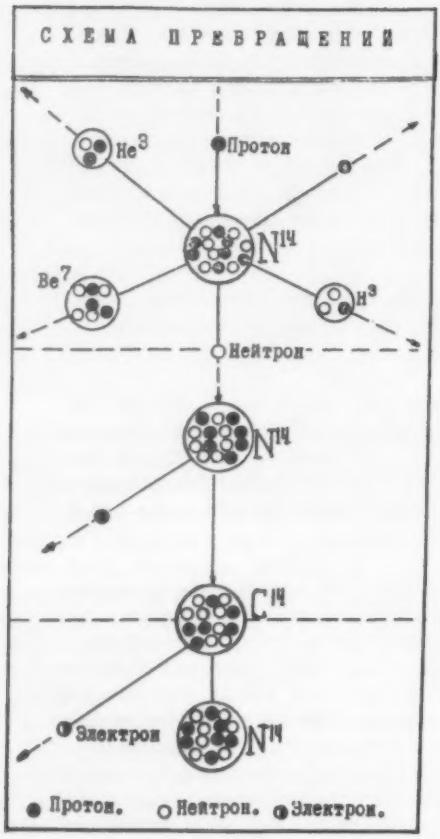
to the earth from outer space. This cosmic radiation encounters first the gaseous envelope of the earth. Among these cosmic particles are free hydrogen nuclei-protons traveling at tremendous speeds. Nitrogen, including one of its isotopes, nitrogen 14, is widely distributed in the gases of the atmosphere. The nitrogen atoms possess an especially intensive ability to "capture" protons, which penetrate into the atomic nucleus of nitrogen and bring it into an excited, unstable state. As a result, the nucleus disintegrates into five splinters: a neutron and a proton, an atom of heavy water (tritium), an atom of helium with mass number 3, and an atom of radioactive beryllium 7. The geochemical functions of these splinters differ. The helium atom and the proton remain in the atmosphere. The tritium oxidizes and enters into the moisture circulation of the earth. The radioactive beryllium is soon converted into lithium and enters the lithosphere. More complicated is the function of the liberated neutron. It again encounters a nucleus of nitrogen 14, is captured by it and brings it, just as in the first case, into an unstable state. The neutron remains in the nucleus, while a proton flies out of it, so that the atom of nitrogen is converted into an atom of carbon with atomic weight 14. This isotope of carbon is radioactive and is again converted into nitrogen 14, emitting one electron in so doing. This complex process constantly taking place in the atmosphere is schematically represented in Fig. 1 (Page 6).

Thus, the radioactive elements tritium, beryllium 7 and carbon 14 are incessantly being created in the atmosphere. Of special interest to the geographer are tritium and radiocarbon.

The former decays rather rapidly, changing into helium 3. Its half-life (i.e., the time during which a given quantity of a disintegrating radioactive element is reduced to half) amounts to 12.46 years, and therefore it can be successfully used in determining the age of rapidly changing meteorologic phenomena -- precipitation, humidity of air masses, as well as the age of lake waters.

Radiocarbon, oxidizing to CO_2, mixes with the gases of the atmosphere and, like ordinary carbon, enters into the tissues of living organisms, is dissolved in sea water and in general takes part in the circulation of the carbon dioxide of the geographic environment. Since the stream of cosmic radiation remains practically constant, a certain equilibrium, maintained by the processes of the exchange of the organism with the surrounding environment, is in the long run established in the biosphere. This equilibrium is disturbed as soon as the organism dies and its replenishment of radiocarbon ceases. The half-life of radiocarbon is about 6,360 years, and after that interval of time a dead organism retains only half of the initial equilibrium content of radioactive carbon. Thus, by determining the quantity of radiocarbon in organic remains, we can determine the time of death of the organism and consequently the age of the deposits enclosing it (it is assumed that the ration between the isotopes of carbon in the atmosphere remains constant).

Transformation Scheme



Stages of the Process

1. A proton of the cosmic radiation is captured by the nitrogen nucleus. The nucleus disintegrates, releasing a neutron.

2. The neutron is captured by another nitrogen nucleus; a proton is released, transforming the nitrogen into radioactive carbon.

3. The neutron in the radioactive carbon nucleus is converted into a proton; an electron is emitted, converting the radioactive carbon into nitrogen.

Fig. 1. The formation of radioactive carbon in the upper layers of the atmosphere and its further transformation into a nitrogen isotope.

The example cited is only one of the nuclear reactions in the landscape envelope of the earth. Reactions are also possible between cosmic radiation and the lithosphere. In this way, for example, arises radiochlorine, with a half-life of 442,000 years. This element can be used to determine the duration of interglacial periods and subaerial interruptions. It would be very interesting to apply it in determining the age of the landscapes of the Antarctic "oases" of the Bunger Oasis type.

3.

What concrete interest do these phenomena have for landscape science? S. V. Kalesnik considers that "landscape science includes both the description and analysis of the existing landscape and the general theory of landscape." From that standpoint, the methods of determining absolute age are interesting because they make it possible to compare geographic phenomena over time.

First, they make it possible to compare rates of change of analogous components in various geographic zones. This applies especially to the comparison of the basic factors of Quaternary glaciation and the interglacial periods on the various continents, as well as to the comparison of the phases of ice-sheet glaciation with the phases of mountain glaciation in the more southerly latitudes. Such work has now been commenced by a number of laboratories, especially in the United States. These methods make it possible to compare the glaciations of North America, South America and Australia. Further development of this kind of research will make it possible to determine the age of certain post-glacial landscapes of the temperate latitudes and the landscapes of the corresponding mountain belts in the lower latitudes.

A similar problem with respect to the present-day climates of coastal regions can be solved by combining this "radioactive clock" method with the investigation of the distribution of manganese in sea sediments. This is apparently possible for the Atlantic Ocean basin, in the sediments of the equatorial part of which the quantity of manganese is in inverse ratio to the temperature of the sea water.

Second, these methods also make it possible to compare on an absolute scale genetically identical forms developed in separate areas. This is especially important for comparing terraces and abrasion levels on various continents or on various shore lines of a given continent. In the USSR, the application of this method will make it possible to compare the late glacial and post-glacial marine transgressions, which will determine the age of strand-flat landscapes fringing the coasts of Europe and Asia. The method is of equal significance for the solution of the problem of the simultaneity or difference in time of the interglacial transgression in the various regions of the Soviet North, where a pronounced wave-cut terrace can be used as a marker in comparing the glaciations of this latitudinal region.

Third, these methods make it possible to evaluate quantitatively the effect of man's activity upon the landscape envelope as a whole. As stated above, the determination of age by radiocarbon is based on the assumption of no change in the ratio between the amounts of various carbon isotopes in the atmosphere; this ratio may be disturbed by two causes: either the intensity of cosmic rays changes with time, and along with it also the quantity of radiocarbon generated, or carbon devoid of radioactive isotopes enters the atmosphere from somewhere.

Experiment and calculations based on the ratio between other radioactive isotopes in the atmosphere shows that cosmic radiation has undergone no substantial changes during at least the last 20,000 to 30,000 years. It only remains to determine whether any new sources of carbon lacking its active isotope have appeared.

This can be accomplished in the following manner: let us suppose that we can determine the age of any object in two ways: first, by radiocarbon, assuming a constant ratio between the carbon isotopes; and, second, indirectly, for example, by counting the layers in ribbon clays or annual rings in the cross-section of a tree trunk. Here two cases are possible: either the two determinations coincide, and then the assumption of a constant isotope composition is correct; or they do not coincide. In the latter case, we can not only take note of the fallacy of our premise, but also compute to what extent the ratio between the isotopes has changed.

Experiments of this sort have been made and have shown that up to the 1870's the carbon composition of the atmosphere had not changed substantially. But since that time there has been a regular enrichment of the air with the non-radioactive isotopes of carbon. It is not hard to find the source of this enrichment. Man is constantly burning an enormous amount of mineral fuel, having an age of 50 to 250 million years. At one time all these substances contained radiocarbon, but since its half-life is insignificant (we have seen that it is only about 6,360 years), mineral fuel of this age contains practically no radiocarbon and, when burned, this fuel gives off into the atmosphere carbon dioxide free of radiocarbon. It has been calculated that the amount of "technogenic" carbon dioxide in the present atmosphere is 8 to 10% of the total carbon-dioxide content.

This fact is of considerable interest for the geographer. The earth can be divided from the poles toward the equator into several zones characterized by the difference in the factors limiting the development of vegetation.

In the zones near the poles, the lack of heat is such a limiting factor. Farther away from the poles lie the zones in which the development of vegetation is limited by a lack of moisture. Finally, in the tropical and equatorial belts the development of vegetation is limited by a lack of carbon dioxide. This is evident from carbon-dioxide distribution curves constructed for north-south cross-sections of the tropical zones. Hence, an increase in the CO_2 content in the atmosphere stimulates the development of vegetation in the tropical forests.

It should be borne in mind that in the landscape envelope the qualitative expression of the progressive intensification of the effect of any component has the character of a sharp jump, not a smooth change. This explains the existence, for example, of sharp geographic boundaries between the zones, although the intensity of the solar radiation changes continuously with latitude. Hence, a further rise in the carbon-dioxide content in the atmosphere may result in a shift of the boundaries of the tropical zones, provided the exchange of carbon dioxide between the hemispheres is active enough. This condition is actually realized; the radiocarbon method has made it possible to determine the rate of such an exchange at 0.5 to 2 years.

4.

The history of the formation of geographic zones and landscapes presents, of course, interest for landscape science, but all these investigations would acquire much greater significance if we were able to evaluate the physical-geographic conditions of these changes and, in particular, to get an idea of the thermal regime of the preceding landscapes.

This possibility is opened up by studying the isotope composition of oxygen that enters into the make-up of calcite of organic origin.

Ordinary atmospheric oxygen consists of a mixture of the isotopes O^{16}, O^{17} and O^{18}, the first constituting 99.759% by weight of the total. Without dwelling upon the theoretical and computational aspect of the question, we shall only point out that the ratio between isotopes O^{16} and O^{18} in oxygen dissolved in water depends upon the temperature. Hence, in the calcite of the shells of marine animals the ratio of the content of these isotopes directly indicates the temperature at which the formation of the calcium carbonate took place, i.e., the temperature of the surrounding water.

At first this "oxygen thermometer" was used by geologists for paleogeographic and paleoclimatic reconstructions. Later, it found application for other purposes, closer to the modern geographer. Broad horizons were opened when three methods of studying young deposits were combined, namely the pollen, the radiocarbon and the oxygen method.

The determination of the absolute age of pollen complexes has made it possible to set up a scheme of most recent changes in the climate of continents on an absolute time scale. On the other hand, the change in the relation between the O^{16} and O^{18} contents in the shells of marine organisms, with simultaneous determination of the absolute age, has enabled us to determine (also on an absolute scale)the course of the change in temperature of the surface and bottom waters of the oceans. In the first case, the shells of pelagic foraminifera were used; in the second, those of benthal foraminifera.

A comparison of the results obtained for continents with the data for oceans made it possible to relate the history of development of present-day landscapes of continents to the history of development of landscapes of present-day seas, which earlier seemed almost impossible.

Such investigations have shown that periodic temperature changes within a range of about 6^{0}C, occurred in the surface waters of the equatorial part of the Atlantic Ocean and in the Caribbean Sea during Quaternary times. In the Pacific Ocean the temperature changes took place less regularly and were of a more local character.

The earliest temperature minimum in the Caribbean Sea corresponds to the first great glaciation of North America. A study of the upper parts of sediment cores obtained in the Atlantic Ocean, and especially interesting from the geographer's point of view, has shown that 16,500 to 6,000 years before our era there was a heating up of the surface layers of the ocean, corresponding to the development of the postglacial climatic optimum on the continents.

It should be noted that the cooling during the last glaciation embraced not only the continents, but also the waters of the Atlantic Ocean, so that the temperature even of the bottom layers in the equatorial part was lowered by 2.1^{0} due to the great southward shift of the limit of floating ice at that time.

Without dwelling further upon these interesting investigations, we shall only note that an essential difference was maintained between the Pacific and the Atlantic Oceans throughout the last stages of the history of the landscape envelope: while the history of the Atlantic Ocean has proved to be closely connected with that of the surrounding continents, the Pacific Ocean has developed more independently.

Similar methods can be applied to the investigation of the temperature regime of fresh-water lakes inhabited by mollusks with calcite shells. This will permit a detailed investigation of the process of development of the present-day landscape on territories freed after the retreat of the ice cap.

5.

If the earth were not surrounded by a complex eletromagnetic field (as is the case with the moon), the arrival of cosmic radiation on its surface would not depend upon latitude and longitude. But the earth does possess a magnetic field, whose complex structure, as shown by the latest space research, reflects the complexity of its internal structure. The presence of such a field, which in general possesses spherical symmetry, disturbs the steady flow of cosmic radiation to the earth's surface in such a way that its intensity varies with the latitude. Hence, at different points in the atmosphere depending upon their geographic location, there is a formation of radioactive elements with differing intensity.

We have already spoken above of the formation of radiocarbon in the upper layers of the atmosphere. There is an analogous formation of other radioactive isotopes -- beryllium 10, sulfur 35 and phosphorus 33 and 32. All these isotopes have different half-lives, ranging from many thousands of years to a few days. By determining, in the precipitation brought by the

air masses, the ratio between the contents of isotopes with different half-lives, it is easy to compute the place of formation of these masses, i.e., to trace the paths of their movement. This sort of research presents great interest for geographers engaged in the study of desert landscapes situated away from the usual cyclone tracks. Investigation by this method of the nature of dry winds in the east of the European part of the USSR would probably yield much of interest.

As is known, the existence of the earth's magnetic field also opens up broad opportunities for paleogeographic research, but this question has no direct relation to landscape science, and we shall not dwell upon it.

6.

Let us turn to certain questions connected with the analysis of the complex relations between the components of the present-day landscape. As pointed out at the beginning of this paper, one of the practical applications of landscape science is the integrated evaluation of lands. It is usually done with consideration for the relief, soils, moisture, types of vegetation and other factors governing fertility. A study of the more subtle relationships between biologic processes and the lithosphere shows, however, that in a number of cases, especially in the development of new regions, such evaluation requires certain additions.

A number of processes in the biosphere depend not only upon the content in the soils of "mass" elements, such as nitrogen, potassium, calcium and so forth, but also upon the presence of trace elements, i.e., very small quantities of such metals as copper, zinc, cobalt, molybdenum, nickel, manganese, etc. These trace elements affect biologic processes by entering into the composition of complex metal-organic compounds,ferments and certain vitamins, that determine the possibility of exchange between the organism and the environment, the possibility of the synthesis of organic compounds and the harmonic flow of biologic processes.

Moreover, some complex organic compounds, including those containing haloids, use the organism to guide the reactions taking place in it, i.e., for the subordination of the central nervous system to their control. In all these cases the metals and metalloids necessary for the operation of all this complex apparatus, are obtained by the organism from the lithosphere through the soil. However, the presence of the necessary metals in the composition of the soils is still inadequate to enable them to pass into the biosphere, since in the soils the metals may be contained in the form of compounds unassimilable by organisms. This factor depends upon the physical-geographic conditions that find their expression in certain features of the landscape.

For example, the absence of copper in plants results in a procumbence disease in gramineae in which the stem breaks and ceases to grow upward. Animals feeding on such plants also begin to feel a lack of copper and, in

the long run, they too may suffer disorders of the central nervous system due to "disadjustment" of the fermentative system that governs the oxidizing and reduction processes and the albumin exchange. However, this picture, characteristic of acute copper deficiency, still does not mean that copper is contained in the soil in insufficient amounts. The fact is that both in very acid soils and in slightly alkaline soils copper forms stable compounds with the organic matter of the soils and cannot pass into plants. This is a characteristic of swamp soils of various zones, for example, Belorussia and Florida, or of certain kinds of steppe or forest-steppe soils (Ternopol', L'vov, Zhitomir and other oblasts). In this case we may speak of a "physiological deficiency."

Equally harmful in a number of cases is the excess of any trace element. For example, molybdenum is indispensable for the nitrogen bacteria living in the soil on the root system of legumes to assimilate the nitrogen of the atmosphere and pass it on to plants. An excess of molybdenum does not harm plants, but animals eating such forage are afflicted by a specific disease (molybdenosis) resulting from the oversaturation with molybdenum of the ferments governing the nitrogen exchange in their organism. In the long run, the disease, as observed in certain regions of Armenia, is also transmitted to man in the form of gout. However, in this case, too, the matter is not so simple. Under certain landscape circumstances the harmful effect of molybdenum can be compensated by an excess of physiologically assimilable copper. This is observed both in certain regions of the Armenian SSR, and in a number of other places -- the Turkestan and Zeravshan Ranges, the gypsum desert of Karnab-Chul', etc. The constancy of such compensation depends upon the landscape circumstances, upon the direction in which the change proceeds and upon its rate. Failure to take this into account in carrying out agronomic measures may disturb the compensation and arouse the harmful action of the excess of the compensated trace element.

Besides this physiological deficiency, one can also observe in nature an absolute deficiency, which manifests itself especially sharply in the case of a lack of cobalt. The latter enters into the composition of vitamin B_{12}, indispensable for the proper formation of the blood. A deficiency causes serious forms of anemia. Such unfavorable regions are known in Latvia, Estonia, Tuva, the foothills of the Kopet-Dag, New Zealand, Australia, Africa (Kenya), as well as in a number of places in England and Canada.

Besides these forms of interaction between the biosphere and the lithosphere effected through the soil under certain landscape conditions, there are other modes of action of the chemistry of the lithosphere upon the biologic processes. As is known, the tissues of animals are made up of many elements, forming as it were the foundation of these tissues, mainly such elements as calcium, sulfur and phosphorus. If under given landscape circumstances they occur in insufficient quantity or in unassimilable form, elements with similar chemical qualities will enter into competition with them. Thus, calcium will be replaced by strontium or beryllium, and sulfur by selenium. Closeness of chemical properties does not coincide with

identity of their biologic characteristics: strontium easily migrates from the bone tissue, where it replaces calcium, and thereby disturbs the solidity and necessary structure of the bone. This entails severe disorders in the organism of animals, known as Urov's disease (urovskaya bolezn'). Similar is the behavior of beryllium, which forms soluble phosphates and then not only disturbs the solidity of the bone tissue by migration, but also contributes to carrying phosphorus out of the organism. Occurrences of excess strontium are usually observed in the landscapes of dry steppes and forest-steppes on non-carbonate soils, i.e., under the conditions for Eastern Siberia, Northern China and certain parts of Korea. This should be borne in mind in developing new lands in the basin of the Amur River.

Equally harmful is the replacement of sulfur by selenium, a substitution that is the scourge of agriculture in the central and especially the western United States, in Hawaii and in Colombia. An excess of selenium, though harmless for plants and even contributing to the development of a specific astragalus (milk vetch) flora, results in the falling of wool in sheep and, in addition, causes severe disorders in life processes.

The deep connection between the chemical composition of soils and biologic processes has led A. P. Vinogradov to the idea of singling out regions characterized by the presence of diseases connected with the characteristics of the geochemistry of the lithosphere and classing them as special biogeochemical provinces. The further development of these ideas is reflected in the work of the Geography Faculty of Leningrad University.

It appears to us that the whole surface of the earth can be subdivided into large biogeochemical provinces of two categories: normal provinces and anomalous provinces. In the former, the geochemical characteristics of the lithosphere do not result in the disturbance of the biologic process. In the latter, they do cause disturbances in its normal course. The normal biogeochemical provinces we subdivide into constantly normal and compensated, in which the apparent favorability is maintained by the compensation of the harmful element by its antagonist. Such provinces represent a potential danger and require great caution in carrying out agronomic measures.

Among the anomalous provinces we distinguish provinces of physiological deficiency, absolute deficiency and excess of a given element. In this series, special interest is presented by the provinces of physiological deficiency, which can easily be converted into normal provinces as a result of the execution of simple agricultural measures.

The mapping of the biogeochemical provinces and their representation on landscape maps of a regional character should be included as one of the priority tasks of modern landscape science.

Since the first hydrogen bomb tests, geographers have been confronted by a new geographic task.

As a result of the series of powerful hydrogen explosions produced in the United States in 1954 and known as Operation Castle, an enormous quantity of radioactive dust, which has been slowly settling down to the present time, was introduced into the stratosphere. It was picked up by the air currents of the stratosphere and scattered over the whole earth. The attached figure (Fig. 2, Page 15), compiled on the basis of published data, shows the latitudinal distribution of one of the components of the radioactive sediments, strontium 90, established in the middle of 1957 (References 1, 3). This figure is interesting for the geographer primarily because it indicates directly the sharp predominance of the west-east circulation in the stratosphere. Indeed, the bulk of the radioactive contamination of the stratosphere falls in the temperate latitudes of the northern hemisphere, i.e., it coincides with those latitudinal belts in which the tests were made. The speed of this latitudinal spread may be seen from the data published in 1957: after the hydrogen bomb explosions in Nevada and on the Marshall Islands, radioactive dust appeared in Europe in 10 to 20 days. A rise in the content of radioactive iodine (iodine 121) in the human thyroid gland occurred in the United States five days after the explosion, and in England and Germany 2 to 4 weeks after it (2). But aside from this, the "erosion" of these latitudinal belts in a north-south direction is continuing slowly, but incessantly. Hence, the radiostrontium content is slowly increasing in all latitudes. Its mean density throughout the globe is about 2 millicuries per square kilometer, which is about 60 to 100 times less than the danger limit. However, its content in the latitudinal belt between Lat. 50^{0} and 40^{0} N. reaches 9 millicuries per sq. km., which is one-seventh or one-tenth of a dangerous dosage(3).

More rapid is the north-south spread of those radioactive particles of the nuclear reaction that are capable of entering into compounds with oxygen and participate in this state in the general circulation of the air masses in the troposphere. For this reason, the growth of the radiocarbon content began in the Southern Hemisphere 20 months after the explosions in the Northern Hemisphere. By May, 1957, it had increased 6.7% in the atmosphere of the Southern Hemisphere, and 2% in the waters of the ocean and in the biosphere. Measuring the augmentation of the quantity of radiocarbon in the atmosphere by May, 1957, permits one to evaluate the power of the hydrogen bombs exploded by that time at approximately 100 million tons of TNT (4).

What is the danger of such a contamination of the landscape envelope from the viewpoint of the geographer-geochemist? We said above that in the lithosphere-biosphere exchange strontium, cobalt and iodine play an immense role. Hence, the appearance in the atmosphere and the settling on the ground of such radioactive isotopes of these elements as strontium 90, cobalt 60 and iodine 121, can have the result that these substances will

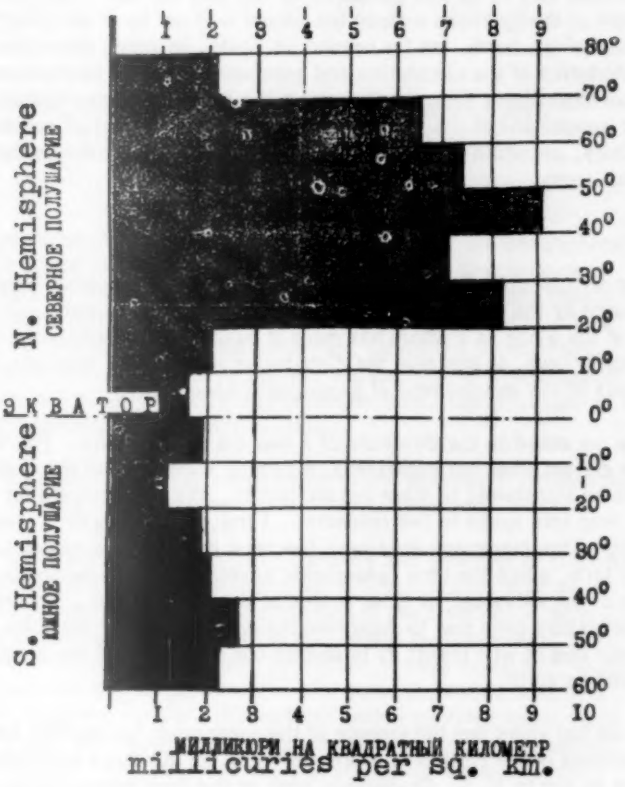


Fig. 2. Distribution of radioactive strontium by latitudinal belts (as of May 1957, according to published data).

get into the composition of ferments, vitamins and hormones of organisms. This is especially dangerous for the anomalous biogeochemical provinces having a cobalt, iodine or calcium deficiency. Here it must be remembered that radiostrontium is a strongly pronounced cancer-producing element, and the required quantity of cobalt is so small (its content in soils in the amount of 8/100,000 of a per cent is sufficient to sustain normal life) that in cobalt-deficient regions radiocobalt may be present in sufficient amount to cause the organism to be saturated with this element. It is not known how the fermentative system will react to such an introduction of radioactive elements, but it may be said in advance that an immense danger for humanity may be concealed there. It may turn out that in the case of mass use of the hydrogen weapon the danger will not be at the place of explosion of the bomb, but far beyond its limits, in zones determined by the characteristics of the circulation and geochemistry of the landscapes. Therefore, we must above all actively support the fight for the prohibition of the atomic weapon and at the same time begin to map the areas of spread and, especially, ascertain those anomalous biogeochemical provinces that overlap such areas.

8.

The breadth of horizon and depth of ideas in geography have been greatly stimulated by the broadening of the arena of geographic activity. Only the study of the globe as a whole has made it possible to ascertain the basic geographic laws, to perceive the distribution and internal relations and dynamics of the development of geographic phenomena.

Now we stand on the threshold of a new era in geography. The time is not far distant when our experience in gaining knowledge of the earth will have to be transferred to other cosmic bodies. We must prepare for such a new leap into space in two respects. First, by drawing up a clear plan of study of the landscape envelopes (we must point out the appropriateness of this term, since the term "geographic envelope" cannot be applied to other bodies of the universe) of other bodies of the solar system. Secondly, it is necessary even now to determine the problems whose study on other heavenly bodies will permit us to deepen our knowledge of the geographic relations on earth.

About ten years ago the thought of the geographer "going out" beyond the confines of the earth was expressed by S. B. Kalesnik in a foreword written by him to A. V. Khabakov's book on the development of the surface of the moon. At that time this bold idea seemed far from realization. Now things have changed and we must exploit this new possibility, this realization of mankind's oldest dream, now being converted into reality in our country of victorious socialism, in order to widen and deepen our science.

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LANDSCAPE FIELD STUDIES IN THE UKRAINE AND THEIR PRACTICAL SIGNIFICANCE

By K. I. Gerenchuk

The five years between the 2nd and 3rd congresses of the Geographical Society of the USSR may be called a turning point in the development of landscape science. From a branch of physical geography that had hardly gone beyond office discussions, was not infrequently subjected to unkind criticism and had very few convinced adherents, landscape science has become a science with a fully defined object and methods of investigation and possessing sufficiently experienced personnel who have proceeded to solve important theoretical and practical tasks.

There are a number of reasons contributing to the successful development of landscape science in the last few years. Among them are:

(a) The resolutions of the 20th party congress and a number of plenums of the party's Central Committee on agriculture, which set the task of: insuring the economically advisable distribution of the branches of agriculture and the regional specialization of farming and animal husbandry with consideration for the natural and economic conditions of each rayon and, within the region, specialization of each kolkhoz and sovkhoz, with a view to a sharp increase in production per 100 hectares with a minimum expenditure of labor and funds. Among the branches of physical geography, landscape science was closest in aims and methods (the integrated study of small areas) to the task set by the party of taking into account the natural conditions of each rayon and, within the rayon, of each kolkhoz and sovkhoz. Naturally, these party resolutions impelled landscape scientists to join widely integrated regional studies for the purpose of developing agriculture.

(b) The Soviet conferences on landscape science held since 1955, at which many moot questions of the theory of landscape science have been discussed, have brought out fields of practical application of landscape research and refined its methods, examined samples of landscape maps at

different scales and, what is most important, geographers have become acquainted with the methods of analyzing and distinguishing landscapes in the course of excursions held during the conferences. The most important result of these conferences has been that geographers of almost all universities and teachers colleges have become interested in landscape science, for they have found in landscape research the most accessible and practically important object of their efforts.

The first experiment in applying landscape research to practical problems was work on the physical-geographic regionalization of the USSR for agricultural purposes. Joining actively in this work were the geographers of the Ukraine, who, at the initiative of the faculty of Kiev University, held in the spring of 1957 a broad conference on physical-geographic regionalization of the Ukrainian SSR, which attracted the attention not only of geographers, but also of agricultural men.

The conference adopted a resolution to compile a map of physical-geographic regionalization of the Ukrainian SSR at a scale of 1:1,500,000 with a text description of the rayons distinguished, noting especially the desirability of an analysis of their landscape-typological structure.

The working up of the basic data - geologic, geomorphic, climatic, geobotanic, soil and other materials - soon revealed a number of serious difficulties arising in the process of regionalization by the use of commonly known methods - the method of the so-called "leading factor" and the method of superimposition (confrontation) of the results of particular kinds of physical-geographic regionalization. These difficulties are especially great in two cases: first, in drawing the boundaries of zones, provinces, oblasts and sometimes also rayons, because not one of the methods mentioned affords sufficiently objective criteria for establishing such boundaries, and, second, in composing the text description of the physical-geographic rayons distinguished, because the description of the separate components of nature on the familiar pattern does not make it possible to distinguish even approximately the typical natural complexes or to evaluate them from the viewpoint of agricultural production.

These circumstances impelled the Ukrainian geographers to proceed to make field studies of the physical-geographic rayons, i.e., to distinguish on the spot and to map the natural complexes encountered in these rayons. Obviously, such investigations could only be selective, by key sections, since we did not possess the means or the time to make complete landscape surveys.

The commencement of modest landscape field studies in the Ukraine coincided with a broad evolution of detailed inspection of the lands of the kolkhozes and sovkhozes of the republic with the purpose of working out recommendations for a sharp increase in agricultural output. A resolution of the Council of Ministers of the Ukrainian SSR dated September 8, 1956, provides for a complete study of the soils of the kolkhozes and sovkhozes

at such a rate that the work in the sovkhozes will be completed in 1960, and in the kolkhozes in 1961.

Not only the oblast agricultural experimental stations and institutes specializing in branches of agriculture, but also the geography faculties of the Kiev, L'vov and Chernovtsy universities and the biology faculty of Uzhgorod University have been engaged in the study. Through participation in this work, geographers have been enabled to: make complete large-scale investigations of whole administrative rayons in various zones of the republic and to make a careful check of the methods of landscape field studies, the procedures for mapping landscape complexes and the opportunities for the practical application of landscape research to agricultural needs.

In the past three field seasons (1957, 1958 and 1959) the field parties of the geography faculties of Kiev, L'vov and Chernovtsy universities have executed large-scale soil surveys in 23 administrative rayons of the republic (in the Volyn', Zhitomir, Transcarpathian, Kiev, L'vov, Odessa, Poltava and Chernovtsy oblasts), the total area of lands studied being over 1,200,000 hectares (L'vov University 549,500 hectares, Kiev University 404,500, Chernovtsy University 280,000 hectares).

The geography faculties made wide use of students specializing in physical geography, organizing preparatory courses as well as courses in the methods of landscape research, and some special courses in soil science (methods of field studies, soil analysis). Over 150 physical-geography students had their field practice in this survey work.

What are the results of the three years' experience with the participation of landscape-science geographers in the agricultural and soil surveys and mapping of the lands of kolkhozes and sovkhozes?

First, the soil-study parties of the geography faculties on the whole coped well with the work to be carried out according to the program of soil surveys of kolkhoz and sovkhoz lands. This has been repeatedly noted in the orders of the Ministry of Agriculture of the Ukrainian SSR.

No less important is the fact that the student geographers also coped well with the soil-study work. They rapidly mastered the methods of soil investigation and learned to correctly recognize soils by morphologic features and have easily grasped the laws of the distribution of soil types and their varieties according to the type of landscape complexes.

Studentsdisplayed serious interest in applying landscape investigations to the tasks of agricultural production and the rational utilization of kolkhoz lands. Course and degree papers by students participating in the soil field parties of the geography faculties has been devoted to these questions.

The second group of conclusions follows from the three years'experience with landscape field studies proper, which were conducted parallel to the soil studies.

First, the fundamental correctness of the doctrine of the morphologic structure of the landscape was confirmed. Experience has shown that the basic morphologic parts of the landscape, the mapping of which is possible with large-scale surveys, are the natural landscape units (urochishcha). The natural unit is a section of the earth's surface that is complex but unified both in geological-geomorphic structure and in the types of biological-soil processes taking place in it, so that a definite series of facies (biogeocoenoses and soil varieties, respectively) is formed in it.

Second, it has been found that natural landscape units, as the sections of the earth's surface having regular series of soil varieties, provide a good basis for agricultural production grouping of soils and qualitative evaluation of kolkhoz and sovkhoz lands. The fact is that not only in the majority of kolkhozes of the Poles'ye and the eroded rayons of the forest-steppe and steppe, but also in many rayons with flat relief one usually observes a great diversity of soil varieties. Thus, in the kolkhozes of Volhynian Poles'ye, with an average land-use area of 2,000 to 2,500 hectares, there are 12 to 20 soil varieties, belonging to 5 or 6 different types of soils. Because of the complexity of the composition and structure of the mother rock and relief, these soil varieties often occupy small areas, and hence the soil maps of kolkhozes present a variegated picture, composed of many dozens, and sometimes hundreds of contours. Hence there is a need for working out a grouping of soil varieties that will take into account their agricultural production possibilities, i.e., provide a qualitative evaluation of the soils, and at the same time suggest ways of distributing the lands and crop rotations more rationally in a given kolkhoz. These purposes are well served by a landscape analysis of the kolkhoz territory, as may be seen from the maps on exhibit.

Landscape investigations find further application at the first level of generalization of agricultural and soil work, in compiling rayon soil descriptions.

A soil description of an administrative rayon should consist, in accordance with the instructions of the Ministry of Agriculture of the Ukrainian SSR, of: (1) so-called "general information about the rayon," in which the climate, relief, soil-forming rocks, hydrologic characteristics, natural vegetation and soils of the rayon are described in detail; and (2) an agricultural production section, giving a detailed characterization of each agricultural production group of soils and agrochemical data and recommendations on the most advisable use of lands and the raising of their productivity; the soil description is completed with an agricultural and soil micro-regionalization of the administrative rayon.

While noting the comprehensiveness of these rayon descriptions, it is necessary to point out certain substantial defects in them, namely:
(a) Disregard of the natural (landscape) complexes, inasmuch as the instructions confine themselves to requiring characterizations of the individual components of the environment. The absence of an integral picture of the nature of a rayon, in which the types of localities found in the rayon are

clearly evident and characterized as territorial combinations of definite series of natural units possessing a certain agricultural production unity in the types of agricultural lands, crop rotations and agricultural production groups of soil, will positively impede the working out of measures for the most suitable utilization of lands and the raising of their productivity.

Thus, in order to work out the most suitable drainage schemes, which most of the Poles'ye rayons of the Ukrainian SSR require, we need an integral characterization of the valley localities, including the lowland meadow and swamp natural units on the interfluves. In order to work out effective measures for combating erosion and the most rational utilization of the eroded lands, there is again need for an integral characterization of eroded valleyside localities, not a characterization of individual elements of the environment.
(b) The absence of an economic analysis of the experience accumulated by seed-selection stations and foremost kolkhozes in the correct organization of the farm territory in accordance with the natural conditions of the given locality. Such an economic analysis would be a definite criterion for the measures recommended for the rational utilization of lands and the raising of their productivity.
(c) The absence of studies permitting one to foresee the most distant prospects of possible land use in connection with the growth of the mechanization of agricultural production, the chemicalization of farming and the raising of the yield of fields and the productivity of animal husbandry, particularly the possibilities of expanding the areas planted to orchards, vineyards and vegetable gardens, climate-ameliorating forest plantings, and so forth.

Considering the above-mentioned defects in the rayon soil descriptions, the geographers of the Ukraine think it necessary to address to the Ministry of Agriculture of the Ukrainian SSR a proposal to supplement the instructions on the compilation of rayon soil maps by the following materials:

(a) characterizations of the natural complexes - types of locality and landscape natural units distributed in each rayon;
(b) an economic analysis of the available experience in the rational utilization of lands and the organization of the territory in the foremost kolkhozes and seed-selection stations;
(c) studies on long-range land use;
(d) landscape maps showing the natural complexes found on the territory of each rayon, and the long-range land-use trends.

Integrated (landscape) characterizations of the environment and the long-range economic-geographic analysis of natural and agricultural production conditions are even more important in the next, still remote level of generalization of soil surveys on an oblast and republic scale. The participation of geographers in this work should grow accordingly.

Undoubtedly, participation in this work will require creative efforts on the part of the geography faculties of the republic both with respect to the preparation of personnel possessing the necessary qualifications for such

investigations and with respect to the most rapid elaboration of the principles and methods of landscape and economic-geographic analysis of field-investigation data for the purposes of long-term planning.

Work on a thorough geographic analysis and synthesis of the materials of soil and landscape investigations has such great theoretical and practical significance that it may be regarded as the most important scientific problem facing the geography faculties for the next several years and therefore it deserves the most serious attention of the geographers of the republic.

In conclusion, let us dwell briefly upon two fundamental questions of practical importance in the physical-geographic regionalization of the country that have found their solution in the course of the field landscape investigations in the Ukraine.

The first question is that of the admissible limit of divisibility in physical-geographic regionalization. There are two viewpoints on this subject. According to the first, there is no natural limit in the division of a territory into rayons, and the degree of minuteness of the rayons to be distinguished is determined by the scale of investigation and its purpose. The adherents of the other viewpoint consider that the ultimate division in the process of regionalization is the physical-geographic rayon as the natural section of territory that cannot be further divided without loss of the individual traits that set it off from neighboring physical-geographic rayons.

The experience in landscape investigations in the Ukraine permits one to solve this controversial question definitely and unequivocally in favor of the second viewpoint. Physical-geographic rayons undoubtedly exist as sections of the landscape sphere that are unduplicated in structure and therefore constitute the final link in the chain of regionalization. Further division of the physical-geographic rayon is possible, but the subdivisions lose their originality and are duplicated repeatedly with greater or lesser frequency over the whole area occupied by a given rayon.

The second question, closely connected with the first, concerns the character of the boundaries of physical-geographic rayons. The opinion has been expressed that the boundaries of physical-geographic rayons (landscapes) are linear, because the boundaries of the morphologic parts of the landscape - facies, natural units and localities - are linear. The experience in detailed landscape investigations shows that in reality even the boundaries of facies and natural units are far from being always linear. As regards the boundaries of landscapes (physical-geographic rayons), they are apparently linear only by way of exception, and most often transitional and blurred, because the natural units and facies of a given type are found over whole geographic oblasts and krays, not merely within a rayon. The differences between neighboring rayons lie, as a rule, in unlike relationships and locations of given natural units, in the predominance of certain types of natural units in one rayon and other types in another rayon, but with the presence of natural units occurring in neighboring rayons. Hence, the boundaries between rayons are usually

represented by gradual transitions from localities with one relationship between natural units to localities with other relationships; and this is the main difficulty in delimiting physical-geographic rayons.

Such are the fundamental conclusions reached by Ukrainian geographers on the above-mentioned controversial questions on the basis of their field investigations.

LET US CLEAR UP, ONCE AND FOR ALL, DIFFERENCES ON METHODOLOGICAL QUESTIONS IN ECONOMIC GEOGRAPHY

By M. I. Al'brut

(From Geografiya i Khozyaystvo, No. 6. 1960. Pages 69- 70)

Previous volumes of Geografiya i Khozyaystvo contained several articles by V. A. Anuchin on theoretical problems in economic geography.

(Actually Geografiya i Khozyaystvo printed only two articles by Anuchin. Al'brut's questions relate mainly to the content of articles by Anuchin published in Voprosy Geografii - Editor, Geografiya i Khozyaystvo). If Anuchin intends to defend his ideas, he will probably be willing to reply to certain questions that puzzle his readers. On that assumption we would like to pose the following questions to Anuchin:

1. The All-Union Conference of Geographers of 1929, in which N. N. Baranskiy participated, adopted a resolution that said in part: "The geographical division of labor is the basic concept of economic geography uniting the research of individual specialized disciplines and the research on individual regions; the geographical division of labor should be the basic category in any scientific system of economic geography."
Anuchin's statement that economic geography is not concerned with the study of production relationships contradicts that resolution. Does Anuchin regard the geographical (territorial) division of labor as the basic category of economic geography?

2. (related to the first). We know that Lenin was the first to introduce an analysis of production relationships into economic regionalization. Economic regionalization happens to be intimately linked with the territorial division of labor. Would Anuchin agree that economic geography is concerned with economic regionalization? If yes, how does this jibe with his statement that economic geography does not study production relationships?

3. (related to the previous two). The economic geography textbooks written for middle schools by Baranskiy and later by others devote considerable attention to the study of production links between and within economic regions. Production links are one of the forms of production relationships.

"By exchanging commodities, people enter into production relationships," wrote Lenin (Collected Works, Vol. 1, p. 122). Is the inclusion of material on production links in the school textbooks consistent with Anuchin's position?

4. Anuchin once clearly stated the scientific unsoundness of the theory of a unity of geography:

"Physical geography deals without doubt with the study of nature and the laws of nature. Economic geography studies phenomena of a social character and deals with the study of phenomena governed by laws of social development. There is no question therefore that it belongs among the social sciences. It follows that there is a fundamental difference between economic geography and physical geography because physical geography studies objects governed by the laws of nature, which determine the character and essence of physical geography as a natural science."

"If geography were to be regarded as a unified science and we ignored those fundamental differences, then it would have to discover and study laws that covered both nature and society. But such special geographic laws do not exist. There are laws of nature and there are laws of social development. The laws of nature do not operate in the spheres of social relationships, and the laws of social development do not govern nature" (V. A. Anuchin, "On theoretical problems in regional geography." Voprosy Geografii, No. 37, p. 183).

Has Anuchin now rejected his views on the fundamental difference between physical and economic geography?

5. D. L. Armand's article "The subject, tasks and aim of physical geography" (Voprosy Geografii, No. 40, 1957) contains a critique of Anuchin's central theme that the geographic environment also contains human society and the results of its economic activity. Armand wrote: "Since the geographic environment consists of nature surrounding society, it is obvious that society itself does not form part of that environment" (p.92), and "To attribute an extremely broad, diffuse and indefinite meaning to the term 'geographical environment' is to distort its philosophical and historical sense" (pp. 92-93). What arguments does Anuchin offer against that criticism?

6. Anuchin wrote sarcastically about the "distribution man" Zhirmunskiy: "Denying the existence of a geography as a whole, Zhirmunskiy acknowledges the existence of separate geographic sciences. There is, for example, a geography of population; it studies the distribution of population. There is a geography of plants; it studies the distribution of plants. There might even be a geography of individual plant species, say, a geography of white wormwood (Artemisia maritima). Zhirmunskiy also acknowledges the existence of an economic geography, whose business is the study of the distribution of production. There is a geography of soils; it studies the distribution of soils, and so forth. It so happens that the principles of distribution of all these objects are, understandably, quite different: population and, say, white wormwood are governed by entirely different

principles of distribution so that there obviously cannot be any unity among the many geographies listed by Zhirmunskiy. Not to mention the fact that in reality such 'isolated geographies,' concerned only with the distribution of individual elements and phenomena, do not by far add up to geography" (V. A. Anuchin, Voprosy Geografii, No. 37, p. 181).

In opposition to the "distribution school" Anuchin evidently asserts that the laws of distribution of population and, say, wormwood are the same.

We would like Anuchin to give a straight answer to the question: Are there, in his opinion, universal laws of distribution, common for both natural and social phenomena?

7. Anuchin states that political economy is concerned with the study of social elements within human society, while economic geography is concerned with social elements within the geographic environment. But can there be any social elements that are not within human society, i.e. outside society? What does he mean by social elements within the geographic environment?

8. What does Anuchin mean with his statement "Productive forces are a part of the geographic environment that is drawn into the process of social production"? Air is drawn into the process of production when air is used for the manufacture of oxygen and nitrogen fertilizer. Can air be considered a productive force? Anyway, how does Anuchin define the category "productive forces"?

9. Anuchin maintains that economic geography is not an economic science. Does Anuchin also reject the thesis that economic geography bases itself as a science on the laws and conclusions of political economy?

These are the main questions that arise in reading Anuchin's work. The replies should lead to a clear definition of various methodological positions in economic geography. This is necessary both in general and in preparation for the coming geographical congress (in Kiev in 1960) in particular. Our questions and the expected replies of Anuchin should be regarded from that point of view.

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(From the editors of Geografiya i Khozyaystvo: M. I. Al'brut sent his questions to the editorial board of Geografiya i Khozyaystvo. The questions are actually intended for V. A. Anuchin, who in the following article expresses his point of view on the subject.)

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ON THE SUBJECT OF ECONOMIC GEOGRAPHY
(Answers to M. I. Al'brut's Questions)

By V. A. Anuchin

(From Geografiya i Khozyaystvo, No. 6, 1960, Pages 71-80)

Basically the preceding letter is devoted to one question - the question of the subject of economic geography, which M. I. Al'brut wishes to clear up "once and for all."

In this connection we must first of all concede the existence of two points of view. Some economic geographers see the subject of their science in distribution (either of productive forces or of social production). In essence that point of view can be termed dualistic because it inevitably breaks the unity of the material world into two parts (natural and social) and draws a sharp, indelible boundary between the natural and the social sciences, specifically between physical and economic geography, no longer making it possible to speak of geography as an integrated science. That view rejects the possibility of general geographic research; geography as a science is "liquidated" and is replaced by the mechanical sum of physical and economic geography. In the process economic geography is torn away from the system of geographic sciences and is made part simply of the system of economic sciences (thus giving rise to a peculiar "science," no longer a geographic economic geography!).

Other economic geographers, supporting the monistic view of geography, start from the recognition of the unity of the material world of nature, part of which is human society. In addition to the further development of physical and economic geography, they see the need for general geographic studies that would synthesize the achievements of both physical and economic geography.

Despite considerable differences on the question of defining the general subject of geography, all supporters of the second school view geography in the concrete form of matter developing under the influence of the interrelationships between nature and society and perceptible in the form of areal complexes.

Being a supporter of the monistic view of geography, the author of this article will try once again to formulate his concept of the general subject studied by geography as a whole, and his concept of that part which is the subject of study of economic geography. At the same time this will also be a reply to the questions contained in Al'brut's letter. (The author has already repeatedly expounded his concept of the general subject of geographic science. See, for example, (1) "On theoretical problems in regional geography," Voprosy geografii, No. 37, 1955; (2) "On the essence of the geographic environment and the manifestation of indeterminism in Soviet

geography," Voprosy geografii, No. 41, 1957; (3) "On theoretical problems in geographic science," Nauchn. dokl. vysshey shkoly, 1959, No. 1.)

While justifying the unity of geography, we concede that there are fundamental differences between physical and economic geography, one of which is a natural science and the other a social science. The essence of these differences is correctly stated in Al'brut's letter, where he quotes from our article "On theoretical problems in regional geography" (see his Question 4). We fully endorse even now the entire paragraph cited by Al'brut.

Fundamental differences between physical and economic geography thus do exist. But they exist within geography and reflect only one aspect of the essence of geography. Another aspect (which Al'brut does not see) lies in the fact that the entire complex of geographic sciences has a common object of study. That object common for all geographic sciences is the landscape envelope of the earth, which, with certain qualifications can be termed the geographic environment.

The landscape envelope of the earth is made up of the earth's surface (together with the bottoms of seas and oceans) plus the hydrosphere and the atmosphere. Besides the lithosphere, air masses, waters, soil cover and biocoenoses, the landscape envelope contains a complex of elements of a social character that have arisen and developed as a result of social production under the determining influence of production relationships. That social complex within the landscape envelope has important distinctive qualities and can in no way be considered part of the biosphere, as some geographers have tried to do in the past. The landscape envelope contains not only the results of man's activity; it also contains human society itself. And regardless of the specific laws of development of that society, regardless of the social structure and social relationships, mankind will remain a component part of the earth's landscape envelope as long as it inhabits the earth.

The landscape envelope differs from the other envelopes of the earth mainly in the fact that life has arisen and developed within it. It offers conditions for the origin and development of life, including life in its highest form - human society. And these very conditions later became the environment within which social life developed. However, not the entire landscape envelope became an environment for society. We can hardly speak of the bottom of the oceans, for example, as such an environment. We must therefore distinguish the landscape envelope as a whole from that part within which society and the rest of nature are in constant direct interaction. That part we call the geographic environment.

The geographic environment, consequently, includes only one part of the earth's landscape envelope, but that part is intimately linked with and dependent on all other parts. For example, the peaks of the Himalayas are

not part of the geographic environment, but as a distributor of moisture for huge areas they exert a strong influence on the geographic environment. The ice of the polar regions is not part of the geographic environment, but it determines the water level of the oceans. If the ice were to melt, many parts of the land now inhabited would be under water and the geographic environment formed in those parts would perish. In short, although we separate the geographic environment from the landscape envelope we must not forget that the entire landscape envelope is indirectly part of the geographic environment. The difference between the two is therefore rather small, certainly qualified and, perhaps, even a little formal. Therefore, while considering the geographic environment as the general object of study for all geographic sciences (including, of course, economic geography), we must make the qualification that some geographic research inevitably will be concerned with those parts of the landscape envelope that do not constitute thus far a geographic environment.

All definitions of the geographic environment as being only a natural category (synonymous with natural environment), in particular D. L. Armand's definition cited by Al'brut in Question 5, are one-sided and therefore incorrect. As we have already shown, such a one-sided definition of the geographic environment can ultimately lead to indeterminism (see "On the essence of the geographic environment and manifestations of indeterminism in Soviet geography," Voprosy geografii, No. 41,1957).

Society and nature are not completely identical. Society is not a mechanical aggregate or a simple sum of biological individua. The life of people is not a simple biological phenomenon; it possesses a specific quality distinguishing it from the rest of nature. But that specific quality does not put human society outside of nature and outside of the earth's landscape envelope; since it exists and develops within the geographic environment, mankind is part of that environment, constituting a component with special qualities. Thus there is no break between society and the rest of nature, but there are internal distinctions within the material world. The interrelationships between society and nature take place within the whole, within nature in the broad meaning of the word.

We often encounter the view that the very term "geographic environment" refers to a condition for the development of something that is not part of it. According to that view, if the geographic environment is a condition for the development of human society, society can in no way be included within the environment. That point of view is only seemingly persuasive. It is true that from a strictly logical point of view something cannot develop within an environment and be at the same time part of that environment. Nevertheless, that is the situation, despite the fact that it contradicts strict logic and a formal, metaphysical way of thinking. "That way of thinking seems to us at first glance quite obvious because it is inherent in common sense. But human common sense, which is a reliable fellow within the four walls of its family circle, experiences the most amazing adventures as soon as it ventures out on the broad path of research. The metaphysical

way of thinking, though quite justified and even necessary in some more or less broad fields, depending on the character of the subject, sooner or later reaches limits beyond which it becomes one-sided, restricted, abstract and gets entangled in unresolved contradictions because it does not see the interrelationships between individual things.." (F. Engles, Anti-Dühring, 1951, pp. 21-22). There is not a single concrete manifestation of social development that takes place outside the social elements of the geographic environment. In this connection we must remember that social production "in general" is an abstract concept that does not exist in reality. In reality it manifests itself in concrete forms. And some forms of social production are elements of the geographic environment of other forms. Production takes place in the geographic environment, but some forms of production serve as environment for the development of other forms. For example, agriculture, which is a form of production, can (and must) be regarded as an element of the geographic environment in the study of industry (especially some branches of industry). Population, with its density of settlement, working skills, etc., can also be regarded as part of the geographic environment in the study of industrial or transportation construction, while industry and transportation are regarded as part of the geographic environment in the study of the possibility of settlement of a given area, or in the study of population in general.

The geographic environment consequently includes the entire complex of material conditions of social development. Starting from such a view of the essence of the geographic environment, we can also easily understand the essential differences in the approach to the study of human society that exists in economic geography (more aptly called social geography) compared with other social, non-geographic sciences. The social elements of the geographic environment are not "outside of society," as Al'brut says (Question 7). They are within society but are regarded by geographers as forming a broader unity than merely human society in itself. Most of the social sciences are concerned with the study of society as a whole. They are concerned with the study of the specific laws of social development that are the causes of that development. They are concerned with all social relationships that exist within human society, including production relationships. In such an approach all the rest of nature is quite legitimately opposed to human society and is regarded as the external natural environment. The influence of the rest of nature on society is regarded as an external influence. Such an approach is absolutely correct in all cases where human society is studied as a whole. Such an abstraction from the actually existing unity of society and nature is necessary for deeper research into the essence of human society as such.

But such an approach becomes incorrect if it is concerned with the study of human society not as a whole but as part of a whole, namely as part of nature. Social geography differs from other social-economic sciences precisely because it is concerned with the study of society and its elements as parts of a larger material unity; it does not study society as such, nor specific internal laws of development, but regards society as a component

part of the conditions under which the process of social development takes place. Therein lies the fundamental difference between social geography as a subject and the social-economic sciences, and therein lies the basis for the unity of social geography and natural, physical geography, which also studies nature not as a whole (that is done by other natural sciences) but as part of a whole, as part of an object of study that is the same for all geographic sciences -- the geographic environment.

It is still customary to transfer mechanically into economic geography certain concepts and definitions from the social-economic sciences that are correct when applied in those sciences but quite incorrect in the system of geographic sciences. The concept of the geographic environment as a purely natural environment outside of human society cannot be of any harm to the social-economic sciences, which are not concerned with the interactions between society and nature, but such a concept of the geographic environment becomes completely unacceptable as soon as we want to study human society as one of the material conditions for its own development, to study it not as a whole, but as part of a whole.

In short, the subject of economic (social) geography is the social elements of the geographic environment and not human society as such. The main distinguishing feature of geography is its concern with the interactions between society and nature as an internal process of development of the geographic environment, in which the complex of social elements exerts on all other elements of the environment a specific, purposeful influence, determined mainly by production relationships.

We thus draw a conventional boundary between economic geography as a subject and the social-economic sciences. But at the same time economic geography has links with a whole series of adjoining economic and technical sciences. It would be silly to deny the existence of such links because basically science as a whole is one, just as matter is one.

We are unable in this article to list all the diversified links between economic geography and other sciences. That would take too much space. But in view of Al'brut's questions (Questions 1, 2 and 3) we will try to demonstrate the links between economic geography and the economic sciences.

If we start from the definition of the subject of economic geography, it is quite obvious that production relationships are studied especially by economic and not by geographic sciences. (For further details on that point, see "Economic geography and the economic sciences," Geografiya i Khozyaystvo, No. 3-4, 1958). But the production relationships determine the purposeful character of the interactions taking place within the geographic environment between society and the rest of nature. And since that is the case, geographers must be familiar with the character of the production relationships that determine at any given time the interactions within the geographic environment.

Economic geography must use the findings of other social sciences,

especially political economy, which is concerned with the study of production relationships. It would be a great mistake to deny the importance of political economy for economic-geographic research (see Al'brut's Question 9).

But it should not be assumed that just because the findings of one science can be used by other sciences, such sciences can merge with one another. Many sciences would be unthinkable without the wide use of the data of mathematics, but it does not follow that they thus become branches of mathematics. Physical geography would be unthinkable without the use of geological data, but that does not make it a branch of geography. Economic geography would be unthinkable without the use of the data of economic sciences (especially political economy), but that does not make it an economic science.

In the process of social production the geographic environment is transformed into a production complex, combining manpower, the means of production and the objects of labor. The same happens with the elements of the geographic environment, and air, when used as an industrial raw material, can of course be regarded as an object of labor, i.e., it is drawn into the process of social production (see Al'brut's Question 8). But the process of social production, into which the elements of the geographic environment (and its complexes) are being increasingly drawn in various forms, represents, as we know, an indissoluble association of productive forces and productive relationships. It follows that as soon as geographers start to study elements of the geographic environment being drawn into the process of social production, they inevitably study them as associations of productive forces with the objects of labor, which cannot be understood in isolation from productive relationships. (Associations of productive forces with the objects of labor will hereafter be called simply productive forces.) Hence, it is obvious that while studying territorial complexes of productive forces economic geographers cannot and must not ignore those aspects of production relationships that affect in each individual case the process of territorial formation of productive forces. In particular, it is extremely important for economic geographers to be familiar with the social, geographical division of labor, which is one of the aspects of production relationships that is especially studied by the economic sciences, but which at the same time often exerts a determining influence on the economic specialization of countries and regions. Hence, the need for economic geographers to study the geographical division of labor and production relationships both within countries and regions and among them.

It should be noted here that the meaning of geographical division of labor has not been adequately worked out from a theoretical point of view. The view that the geographical division of labor is synonymous with social division of labor taken as an areal expression arouses serious doubts, and in our opinion can hardly be considered correct. Of course, any division of labor is social in character. But not every social division of labor can be called geographical.

It is quite obvious, for example, that the division of labor within an enterprise is of a technical-economic character and not geographical, except where parts of the enterprise are located under different geographical conditions. Nor can the division between physical and mental labor be called geographical; the same applies to any form of occupational division of labor.

In a class society we must evidently distinguish two basic forms of social division of labor: a social division of labor caused by class differentiation and a social division of labor caused by the interaction between human society and the rest of nature, i.e., formed in the process of development of the geographic environment. In a class (capitalistic) society these two forms tend to overlap, with the division of labor caused by class differentiation dominating and often distorting the division of labor produced by the interaction between society and nature.

The social division of labor caused by class differentiation can be called capitalistic or class division of labor. It is a historical category, arising under the conditions of a class society and disappearing in a society where class differentiation is abolished. In a capitalist division of labor, the results (commodities) constitute materialized forms of social, class relationships that cannot have any substantial territorial differences. It was these relationships that Marx had in mind when he equated division of labor with private property. "The division of labor and private property are identical expressions." (K. Marx and F. Engels, Collected Works, Vol. 3, 1955, p. 31). Such a class division of labor in itself is not geographical in character and is not identical with the geographical division of labor. However, in specific cases the two can overlap because social relationships leave their imprint on the interactions between society and nature.

The geographical division of labor (in its pure form) is a category that is basically independent of the character of production relationships. It has existed since the dawn of human history and can disappear only with the end of mankind. In a geographical division of labor the results (commodities) constitute materialized forms of the interaction between society and the rest of nature, and that interaction will exist forever. We know that the interaction between society and nature is clearly geographical in character. For any given social system it would differ among countries and regions because it depends on the geographic environment, which will never be uniform over the entire surface of the earth.

Having been caused by areal differences in the process of interaction between society and nature, the geographical division of labor in turn governs the productive specialization of countries and regions, and consequently the productive links among them. The geographical division of labor is therefore a special form of production relationship that cannot be perceived just from the point of view of the social-economic sciences because it is based on the existence of the material unity of society and nature. Therefore the geographical division of labor is one of the basic categories "in any scientific system of economic geography" (see Al'brut's Question 1).

Under communism the geographical division of labor will be freed from the crippling influence of the capitalist mode of production. It will then fully express the new production relationships between collectives of free producers struggling against nature under various environmental conditions and therefore producing different products of their labor. But even under communism not every division of labor would be geographical because there will still be a technical-economic division of labor based on interactions within society rather than between society and the rest of nature. The technical-economic division of labor is not a "category of economic geography."

The future forms of social division of labor will inevitably continue to interact with each other. But they will not be antagonistic in character. The geographical environment will no longer be crippled,and geographical resources will no longer be recklessly exploited. Society's action on nature will be directed toward full utilization of its resources and conditions with simultaneous conservation and transformation in the interest of mankind.

In short, economic geography definitely concerns itself with many questions relating to the study of production relationships. In many cases economic geographers have to "invade" the field of technical and agricultural sciences, study problems of a historical character, and make wide use of statistics. But it does not mean that those questions, studied by economic geographers to a greater or lesser degree, are part of the subject of economic geography. The content of a science and the subject of that science are far from being one and the same. If we were to include within the subject of a science the entire complex of questions studied by it (and constituting its content), then in view of the interconnections between sciences, there would be no boundaries whatever between sciences and there would be no need for attempts at classification.

The subject of a science should determine its specific features; it should determine differences (and not similarities) between it and other sciences; it should determine the specific tasks of the given science. The subject of economic geography is the territorial complexes of productive forces, or, if we look at the subject somewhat more broadly, the social elements of the geographic environment.

That subject is studied by economic geography chorologically, i.e., through the use of the geographic method, which encompasses the study of all objects and phenomena in their development expressed in terms of areal differences. In that sense the term "chorology" can be replaced by the term "distribution" because both terms express the methodological (rather than the subject) character of geography. One of the forms of the geographic method is regionalization.

From the foregoing it should be clear that all forms of geographical writing, including textbooks, should include not only the results of research relating directly to the subject of geography, but also the results of adjoining sciences

that explain or help to explain certain aspects of the subject of geography. In particular, all questions relating to the study of production relationships, without which the process of territorial formation of productive forces cannot be understood, and the specific characteristics of those relationships must of course be parts of the content of economic geography and therefore be included in all forms of economic-geographic writing. The same applies to production links, some aspects of the technology of production, elements of agricultural technique, and so forth.

Now a few words about regionalization. Regionalization does not express the material object of study but a very important form of the method of geographical perception. Regionalization is a methodological, not a subject category. By means of regionalization (geomorphic, climatological, physical-geographic, or industrial, transportation, agricultural, economic-geographic) geographers study the geographic environment both in terms of individual component elements and in terms of complexes of such elements. There can be no geography without regionalization because geographers perceive their study objects in terms of territorial complexes, and consequently all geographic research starts with and ends with regionalization. Such a regional approach is the methodological basis of any of the individual geographic sciences and of geography as a whole. Chorology, territoriality, regionalization, distribution, differences from place to place -- all these concepts used by geographers, despite particular differences, essentially express the same thing. They express the geographic method.

The idealism of Hettner's concept, as well as the idealism of present-day supporters of the distribution school in economic geography, lies in the fact that they make a methodological category the subject of the discipline and thus try to deprive geography of its materialistic character. (In fact, what kind of a science do you get by depriving it of a material object of study!).

The geographic method in specific terms consists, above all, of regionalization and mapping. The results of any concrete geographic research can always be expressed cartographically. The map, as N. N. Baranskiy often says, is one of the main criteria of geographical research. Regionalization and mapping are not ends in themselves, but the means for perceiving the geographic environment. Therefore the very posing of Al'brut's question cannot be regarded as correct, in our view.

The geographic method, and consequently also regionalization and mapping, is not a monopoly of geography. If economic geographers include in the content of their science many questions from adjoining sciences (without which the object of study specific to geography cannot be perceived), by the same token the geographical method and many geographical findings are widely applied and used by non-geographic sciences.

Regionalization is of considerable practical importance because it is applied not only in the process of scientific perception but also in the process of economic administration. In particular, when we speak of economic-

geographic regionalization it must be emphasized that the importance of identifying objectively formed economic-geographic regions (or regions in process of formation) lies not only in the fact that it helps perceive territorial complexes of productive forces but also in the fact that economic-geographic regionalization furnishes the basis for governmental regionalization, which in turn is a major method of economic planning in countries with a Socialist mode of production. That is an additional reason why Soviet economic geography should have the regional approach as its methodological basis.

Many scientists in various fields of knowledge have used and continue to use the regional research method. The founders of Marxism-Leninism have also devoted much attention to the regional research method. It is well known, for example, that Lenin devoted much attention to the problem of economic regionalization, as pointed out by Al'brut in his letter (Question 2).

In the field of economic geography the regional approach constitutes the main approach, and that is true especially of Soviet economic geography. A major role in introducing the regional approach into Soviet economic geography was played by Lenin's work, which was used as the basis for working out certain specific methodological questions of economic geography. Economic and economic-geographic regionalization can of course be studied separately, as part of a special branch of study -- the methodology of economic geography. But regionalization is not a concrete, material object and cannot be studied in that sense. We repeat, regionalization is a method, not an object.

In conclusion, we should like to say that one of Al'brut's questions (Question 6) is rather puzzling. He says: "In opposition to the 'distribution school' Anuchin evidently asserts that the laws of distribution of population and, say, wormwood are the same." Anuchin never made such an original statement.

THE MAIN TASKS AND TRENDS OF GEOMORPHOLOGICAL RESEARCH IN THE USSR

(Introductory paper read in April 1960 before the first expanded plenary meeting of the Inter-Departmental Geomorphological Commission under the Division of Geological and Geographical Sciences of the Academy of Sciences of the USSR)

By I. P. Gerasimov

(From Izvestiya Akademii Nauk SSR, seriya geograficheskaya, No. 5, 1960, Pages 88-95).

In the total volume of scientific and practical scientific research now being done in the field of geomorphology, in the number of specialists engaged in this research and in the breadth of range of theoretical questions of geomorphology and its application in practice, the Soviet Union at present unquestionably occupies first place in the world.

A good illustration of this is the program of the present conference. It is being opened with a display of a series of geomorphic survey maps embracing both the whole territory of the Soviet Union and its major parts (for example, the Siberian Platform, the Arctic, etc.), each of which surpasses major foreign countries in area. The program of the conference also provides for the discussion of many theoretical questions, methods of geomorphic field surveying, a broad exchange of information on the new factual material, and concludes with an examination of the question of the training of young cadres of geomorphologists and with information about the coordinating plan for work being done on geomorphology in the USSR.

However, what has been said about the leading position of Soviet geomorphology is based for the time being on the external manifestations of the conference. It is considerably more difficult to bring out in a brief introductory talk the advanced position of Soviet geomorphology in terms of ideology, i.e., to show the theoretical depth of geomorphic work already attained in the USSR and the broad prospects of Soviet geomorphology, especially in that respect. I shall nevertheless try to do this.

A modern textbook in geomorphology, quite popular in the United States of America, by Professor William D. Thornbury of Indiana University under the title Principles of Geomorphology (1954-1957) begins with a brief list of fundamental concepts underlying this scientific discipline. The essence of these concepts is expounded in a few brief theses. Among them, the following should be especially singled out:

1. The fundamental principle of modern geology (uniformitarianism, i.e., actualism), formulated as follows: "The same physical processes and laws that operate today operated throughout geologic time, although not necessarily always with the same intensity as now."
2. The principle of structural geomorphology: "Geologic structure (the physical and chemical properties of the subsurface) is a dominant control factor in the evolution of land forms and is reflected in them."
3. The principle of genetic geomorphology: "Geomorphic processes leave their distinctive imprint upon land forms, and each geomorphic process develops its own characteristic assemblage of land forms."
4. The principle of evolutionary geomorphology: "As the different erosional agencies act upon the earth's surface there is produced a sequence of land forms having distinctive characteristics at the successive stages of their development" (geomorphic cycles).
5. The principle of historical geomorphology: "Proper interpretation of present-day landscapes is impossible without a full appreciation of the manifold influences of the geologic and climatic changes during the Pleistocene" (let us add, of older geologic periods, as well).
6. The principle of climatic geomorphology: "An appreciation of world climates is necessary to a proper understanding of the varying importance of the different geomorphic processes."
7. The principle of paleogeomorphology: "Geomorphology, although concerned primarily with present-day landscapes, attains its maximum usefulness by historical extension" (geologic history).

I do not think that it would be possible to dispute the correctness of each of the above principles taken separately. Moreover, it is quite possible to link

anyone of them with a definite classic or recent scientific trend in world geomorphology characterized by certain scientific achievements and by the names of representatives of that school. From this point of view, the basic content of the above-mentioned American handbook merits a positive evaluation. In a fairly brief and comprehensive manner, it makes a systematic review of the principal theoretical notions in the field of foreign geomorphology. And although the basic concepts worked out in the so-called "heroic age" of American geomorphology (1875-1900) and linked with the names of Powell, Gilbert, Dutton and Davis, are advanced to the forefront in the book, due space is nevertheless allotted to the views both of the European founders of geomorphology (Hutton, Playfair, Lyell and others), and to the latest investigators (especially W. Penck).

I have taken as an illustration of the present state of the general scientific theory of geomorphology in foreign countries, a widely used American textbook. It might be replaced by many other major handbooks written in other languages, for example, French or German. Of course, in each of these handbooks one would discover both certain merits and certain shortcomings compared with the one discussed above. However, one general characteristic would stand out in all such modern handbooks used for the training of new geomorphologists, namely the large number of particular principles advanced and the absence of a general ideological focus uniting the particular propositions, sometimes contradictory in content, into a single, integral conception. Using a well-known philosophical term, one might say that the main defect of the present instruction handbooks in geomorphology is their eclecticism, i.e., the absence of a single broad ideological conception underlying the formation of the scientific viewpoint of the young geomorphologist.

Another illustration of the ideological-theoretical eclecticism in the interpretation of the basic content of modern geomorphology, which, unfortunately, is also sometimes the case in the USSR, is the dispute about the system of sciences to which it belongs. Geomorphology is assigned either to the system of the geographical or to that of the geological sciences, either classification being justified by arguments of a historical, methodological or practical character that are usually correct when taken separately but contradictory when taken together. The disputants, in my opinion, forget about the possibility of a single true dialectic solution of such a question - the simultaneous inclusion of geomorphology as an independent borderline science between both systems of sciences, geographical and geological, which would most accurately accord with the advanced general theory of geomorphology and with its progressive methodological standpoints.

The eclectic state of the general theory of geomorphology abroad today is the result of the historic course of events and an indication of a certain stage of development. The general history of development of foreign geomorphology may be briefly conceived in the following manner. This science was the fruit of two mothers having a close natal relationship. In the concealed, uterine stage of its existence, it developed in the bosom of both physical geography and physical geology, gathering strength in the nutrient medium of both sciences. Geomorphology at first declared its right to independent existence in the geological sciences. This happened, as is known,

in the so-called "heroic age" of American geomorphology, i.e., in the last quarter of the 19th century, in the United States. It was there, in the Far West of the United States, that the independent voice of this infant first spoke out, to the astonishment of its geological parents, in a loud geographic accent.

Despite its regional origin, the American infant quickly captured the whole world, and Davis' conception of the geomorphologic cycle was for a long time the banner of the new science. However, at the end of the first quarter of the 20th century the classical German descriptive physical geography gave birth to a new geomorphological child. This geographic Wunderkind invented morphological analysis and with that weapon boldly invaded the forbidden geological sciences(considered tectonic possessions), successfully repulsed the onslaught of the alarmed owner and at the same time entered into a fierce skirmish with its American kinsman. The protracted struggle, which has not yet ended, has resulted in a tie.

These are the circumstances under which geomorphology passed its stormy youth abroad. Having won its right to an independent existence, this science has at the same time proved itself inadequately prepared for the complex trials of life. Alongside a continued energetic growth, which, to be sure, has lately been more quantitative than qualitative, there have appeared the first symptoms of disease, for example, eclectic self-complacency with respect to theory, dogmatic interpretation of certain scientific concepts (of the geomorphologic cycle), a formalistic approach to the solution of certain scientific problems (for example, problems of erosion surfaces), hypertrophied development of certain trends (so-called climatic geomorphology), and so forth.

Russian geomorphology has, of course, been strongly influenced by world geomorphology in its advance. But even in pre-revolutionary times it had many special characteristics of development. In Russia, geomorphology was formed in the womb of twin mothers: physical geography and geology. Russian scientists -- the top men of Russian geography, such as Semenov-Tyan-Shanskiy, Dokuchayev, Kropotkin, Anuchin, Borzov, Berg, on the one hand, and the great Russian geologists, Mushketov, Karpinskiy, Cherskiy, Nikitin, Pavlov, and Obruchev, on the other -- made great contributions to the development of geomorphology. On that foundation, Russian geomorphology created a vast capital of valuable facts and regional generalizations and assured itself precedence in the solution of a number of important theoretical problems (for example, the laws of development of erosional relief forms; questions of glacial paleogeomorphology; the role of neotectonics in the formation of the present relief, etc.). In spite of this, it must be acknowledged that the formation of geomorphology as an independent science, with its own subject matter, general theory and methods, proceeded at a comparatively slow rate in pre-revolutionary times. Perhaps it is precisely for that reason that there sometimes still exists a tendency to refuse geomorphology a pass to independent existence. For example, some of our great geologists, while widely using geomorphologic

knowledge and methods in their work, sometimes regard the latter solely as subordinate elements of geologic methods. It is clear that such tendencies exert a more or less retarding influence upon the development of independent theoretical thought in geomorphology.

As in many other scientific disciplines, entirely new conditions and a new stage of development arose in Soviet times for the development of Soviet geomorphology.

Because of the high demands made upon science by the vast program of Socialist construction, there has been a continuous increase in the volume of practical scientific work in geomorphology relating to the demands of industry, agriculture and transportation. This volume, as already stated, cannot be compared in scale with the geomorphologic work done in the largest foreign countries. For this reason both the positive and negative elements of the modern scientific theory and methodology of geomorphology manifest themselves more acutely in the Soviet Union than elsewhere. On the one hand, Soviet geomorphology is faced with responsible practical tasks and great hopes and expectations are placed in it (for example, in finding productive petroleum and gas-bearing structures, in the field of water-power development, in prospecting and exploration of alluvial mineral deposits, etc.). On the other hand, mistrust or disappointment is often expressed with the methods and results of the geomorphologic investigations that have been made, and they are sometimes fully justified. Take, for example, the detailed geomorphic mapping that has been so widely developed lately in the system of geological surveying. In spite of the extensive factual material obtained by geomorphic mapping and its value for an understanding of the relief characteristics of the Soviet Union, this work has, of course, serious shortcomings of a methodical character and in terms of practical results. These shortcomings are well known to geomorphologists and will, of course, be the subject of discussion in our conference.

But in making various practical demands upon Soviet geomorphology and in criticizing the weaknesses and errors of our science, sometimes sharply and by way of self-criticism, we must not forget the high theoretical and responsible practical level of such demands and criticism. For example, Soviet geomorphic surveying suffers, in our own opinion, from a number of serious shortcomings; however many of them are due above all to the fact that geomorphic surveying in the USSR is done on a scale and in a volume unknown anywhere else. From him to whom much is given much will be demanded. And it must be frankly acknowledge that the preconditions for the successful development of geomorphology and its practical application are especially favorable in the Soviet Union. We have, first of all, the general reliable support for special-purpose theoretical scientific research in the form of an advanced philosophical system of dialectical materialism, the creative application of which in the special fields of scientific knowledge is an important methodological task of every Soviet scholar. Add to this the profound progressive traditions of Russian science, carefully preserved in a number of the country's scientific centers and its

precedence in the elaboration of a number of most important problems in the field of geomorphology and related sciences. Finally, let us again note the immense range of practical scientific work being done in geomorphology by the great army of geomorphologists who are at the main source of scientific knowledge - the direct field study of nature.

An attempt on my part to anticipate the results of our theoretical discussion in the present introductory remarks would be premature. Still, in order to compare the starting point of the discussion in our conference with the eclectic theoretical base of foreign geomorphology it is probably well to formulate, at least in very brief form, a number of fundamental theoretical propositions of Soviet geomorphology, which, of course, have a distinctly different character from the "fundamental concepts" set forth in the American handbook above.

These propositions are:

1. Soviet geomorphology is at present an entirely independent science, forming a part of the system of geological-geographical sciences. It has its own subject matter, general theory and method. The subject matter of geomorphology -- the relief of the earth's surface -- is at the same time a component of the modern natural geographic environment and a product of the geological development of a territory.

2. According to the general theory of Soviet geomorphology, the relief of the earth's surface is formed by the continuous, historically developing interaction of external (exogenic, physical-geographic) and internal (endogenic, geologic) factors. This interaction is of a very complex multicomponented character. Involved are multiform natural processes and phenomena both of a cosmic (planetary) and of a general terrestrial and local character. In this connection the earth's relief involves elements at various scales-- planetary (I have proposed that they be called "architecture of the earth"), regional (the morphologic structure of the earth's surface, according to my proposal) and local (local (in my terminology, "morphologic sculpture of individual sections of the land and sea floor").The phenomena and processes of the respective level play the key role in the formation of the relief elements of each of these scale categories; however, the relief-forming phenomena and processes of a higher category, of course, always exert a direct controlling effect upon the development of the relief forms of a lower category.

On the other hand, the development of the individual sculptural relief elements usually takes place under the direct action of only a given elementary natural process or phenomenon; the combination of local (sculptural) elements, characteristic of the different regional (structural) forms of the earth's surface and its architecture, represents the result of a considerably more complex action of the conflicting sum of many diversified elementary phenomena. Because of this, all the relief elements of the earth's surface -- from the largest to the smallest -- are closely interrelated, and they must always be studied with a view to such an interrelationship.

3. The guiding scientific method of geomorphology is geomorphic analysis. Its purpose consists in establishing the course or history of the formation of a given element of the contemporaneous (or ancient, fossil) relief of the earth's surface, or of its entirety by ascertaining the sum of endogenic and exogenic processes and phenomena acting upon the object under study throughout its existence. In doing so, geomorphic analysis should proceed from the recognition of the continuity of action both of the endogenic and of the exogenic factors of relief formation; however, the intensity of the manifestation of these factors may and should, of course, vary a great deal, being, as a rule, of a periodically fluctuating character. Hence, the principle of time of formation (age) of any relief element of the earth's surface is used in Soviet geomorphology both in relative (conditional) and in absolute (historico-geologic) terms.

Soviet geomorphologic research uses various working methods and scientific data. Of leading significance in the system of geomorphologic research, however, is and should be the direct field study of relief and of the main factors of relief formation (i.e., endogenic and exogenic phenomena and processes). No other methods of conducting geomorphologic research (for example, the office study of cartographic and other materials) can or should replace the field study of relief. However, the latter should now be supplemented by other working methods to the greatest possible extent. Among them are, first, the office analysis of literature and maps; second, laboratory analysis of the specimens collected; and third, stationary observations of the natural dynamics of the relief and experimental work on the artificial modeling of relief-forming processes.

The necessity of supplementing geomorphic field observations with office and laboratory experimental work is imposed by the present level of the science and the practical demands upon Soviet geomorphology to furnish not only qualitative characterizations of the relief but also quantitative indices as a starting point for technical- economic estimates and plans. For this reason, Soviet geomorphic research now attaches special importance to various morphometric and aerophotogrammetric materials on relief and to precise lithologic characterizations of the substratum of the relief forms.

While giving such quantitative indices their due, one cannot fail to emphasize that they are thus far of only accessory significance in geomorphic research. The exceptional complexity of the genesis of relief forms of the earth's surface as a product of the historically developed and conflicting interaction of a complex multi-componented system still restricts the application of even the most perfect mathematical apparatus in geomorphology. The first and decisive step is therefore the thorough qualitative analysis of a natural phenomenon, i.e., the result of the scientific study of the concrete characteristics of the relief of the earth's surface on the basis of earlier established general theoretical laws. Only within the general framework of such a qualitative approach and under its direct and constant control is it now possible to apply various methods of quantitative research. Only under this condition will the latter avoid acquiring a purely empirical

character and be more or less guaranteed against an excessively abstract or contrived (speculative) approach to the objects studied, such as may be seen in certain well-known foreign studies.

The principal kind of geomorphic research in the USSR is the field survey. Its subject matter embraces the relief of the earth's surface and the substratum. The study and mapping of the substratum of the relief, i.e., the lithologic composition of rocks and deposits, are necessary to insure the genuinely scientific character of the relief investigation (i.e., the ascertainment of its origin and age), as well as to satisfy the various practical demands in a thoroughgoing manner. To the above it should be added that the study of a considerable part of the geological formations and, above all, of the strata of rocks and deposits of continental origin is also inseparably connected with a thorough study of the relief. It must therefore be firmly borne in mind that a thoroughgoing geomorphic field survey represents a responsible type of scientific research that can and should be carried on by specialists well trained for that purpose.

Although geomorphic field surveying is the main source of new systematic factual data on the relief of the studied territory and on the composition of its surface deposits, as well as the scientific basis for the solution of various practical problems facing geomorphology, it does not, of course, exhaust the various kinds of geomorphic work being done in the Soviet Union. This work is of a diversified character depending on its purpose, and the trends and methods of geomorphic research have become more and more diversified with the passage of time. It may be stated that, in the main, from a "de facto" rather than a "de jure" point of view, many of the tasks and trends of practical scientific research that were until recently regarded as the specialty of purely geologic or geographic work are being shifted increasingly to the shoulders of geomorphologists. Examples are the prospecting for alluvial deposits of minerals; agricultural research on the problem of the rational utilization of lands and the control of water and wind erosion; morphotectonic research aimed at finding recent geologic structures or determining the trend of development of old structures in recent times; geomorphic research relating to seismology and hydraulic construction, and various kinds of hydro-geology and engineering-geology research.

One cannot fail to see that this characteristic phenomenon of our times is the result of the rapid progress of science and its increasing differentiation and specialization. Hence, it is hardly reasonable to oppose this course of development of scientific and practical work. Nor is it worthwhile getting particularly alarmed about the fact that such shifts are often still taking place within a given science or practical specialty and have not yet received their full external expression or shape. Something else is considerably more important: namely, the great new responsibility with respect both to general theory and to practice, which falls upon geomorphology, whether officially recognized or still concealed in the bosom of some mother science. Many factors, already enumerated above, determine the immense potentialities

of our young and actively developing science, which are quite sufficient to solve successfully the new tasks set by the times. However, for these potentialities to be converted into effective means and results, a great deal of energetic work still needs to be done. So, it is up to us, geomorphologists, the loyal adepts of this remarkable young science.

All the foregoing permits me to conclude this talk by emphasizing three principal tasks confronting our conference.

First, to examine critically the present state of the general theory of Soviet geomorphologic science, above all from the viewpoint of greater consolidation of its positive elements for the development of an advanced theoretical conception that will insure the further independent progress of geomorphology in the USSR and in the whole world, and its full use for practical purposes.

Second, on the basis of a mutual exchange of the enormous practical experience, to ascertain the most efficient and theoretically well-founded methods of geomorphic research and productive ways of utilizing it for the most rapid solution of urgent practical demands.

Third, to discuss from every aspect the organizational state of Soviet geomorphologic science to provide a freer outlet for existing progressive tendencies and, in particular, to examine the questions of training new cadres and the most rational utilization of young geomorphologists.

Such are the most pressing tasks of the discussion to be organized in our conference. We may firmly count on it to be generally successful and to produce concrete results.

The present conference is being held in the period of fulfillment of the great seven-year plan for the development of the USSR national economy, which is laying the material foundation of a Communist society. Now being worked out are also the principal propositions of the general long-range plan for the development of the USSR national economy, on the basis of which our country will emerge as the first in the world in the production of material blessings. Most of these are based on the mineral wealth and other immense natural resources of our country. Geomorphologists form an important team of prospectors for natural resources, and, being devoted sons of their fatherland and active builders of the new life, they should make a maximum contribution to the great cause of fulfilling and overfulfilling our national-economic plans.

THE GEOGRAPHY OF TRANSPORTATION OF KAZAKHSTAN

By I. V. Nikol'skiy

(From Geografiya i Khozyaystvo, No. 3-4, 1958, Pages 47-54)

The Kazakh SSR occupies an area of 2.8 million square kilometers, bounded by Central Asia, the Volga region, the Urals, Siberia and China. This geographical location has promoted the development of important transit routes in Kazakhstan.

Railroads handle the dominant part of Kazakhstan's transportation, moving about 80 per cent of all freight (in ton-kilometers); a good deal of freight is also moved by trucks, while water and pipeline transportation plays an insignificant role.

The development of heavy industry and a sharp increase in farm production have led to a rapid rise in railroad freight turnover in Kazakhstan. The rate of growth of freight movements has considerably exceeded the rate of growth of the railroad network. While the rail net expanded by about five times from 1913 to 1956, total freight turnover (shipments plus arrivals in tons) increased by 100 times during the same period.

Freight shipments and arrivals
on the railroads of the Ministry of Railroads
in the Kazakh SSR
(in thousand tons)

Types of Freight	Outgoing			Incoming		
	Years			Years		
	1940	1950	1956	1940	1950	1956
All freight	15,525	35,176	66,558	12,216	27,993	52,927
of which:						
Coal and coke	6,075	16,458	30,004	3,896	9,800	15,457
Iron and steel (including scrap)	94	441	949	188	677	1,463
Ores (Including iron pyrites)	643	4,324	5,596	497	2,121	2,149
Timber	237	309	367	1,520	3,013	5,136
Firewood	307	181	141	280	232	327
Grain	1,451	2,203	9,665	872	1,137	3,817
Building Materials	4,318	6,990	12,021	2,164	5,927	12,063
Others	2,321	3,499	6,352	2,058	3,830	8,081

Coal accounts for more than 45 per cent of all outgoing freight. The location of the main coal-mining districts is reflected in the distribution of the railroad

turnover by oblasts of Kazakhstan. The Karaganda economic administrative region, besides coal, also contains the republic's main copper-producing centers, a developing iron and steel industry and a large building-materials industry. The region accounts for 60 per cent of Kazakhstan's total outgoing railroad freight, and all three economic administrative regions of northern Kazakhstan (Kustanay, Karaganda and North Kazakhstan) account for 70 per cent of all outgoing freight.

In Kazakhstan as a whole, outgoing railroad shipments exceed incoming freight. But that balance of freight movements holds true only in four oblasts -- Karaganda, Pavlodar, Kokchetav and Aktyubinsk; in each of the 12 other oblasts, incoming freight exceeds outgoing shipments. Coal, ores and building materials are the principal outgoing freight in Karaganda Oblast; Pavlodar Oblast ships mainly coal from the Ekibastuz district, building materials and grain; Kokchetav Oblast ships building materials and grain, and Aktyubinsk Oblast nickel and chrome ores.

The mining of iron ore in the Sokolovka-Sarbay district of Kustanay Oblast (around the city of Rudnyy) began in 1957; in the next few years production is expected to rise to 15 million tons. If we bear in mind, in addition, that bauxite shipments will soon start from the new mining district of Amangel'dinskiy Rayon (at Arkalyk) and grain shipments are expanding, it becomes clear that in the next few years outgoing freight will greatly exceed incoming freight in Kustanay Oblast as well.

The rapid growth of freight turnover and the large amount of transit freight on certain trunk lines have produced a high freight-moving intensity in some directions. The highest freight-moving density (Fig. 1) is found on a section of the Trans-Siberian Railroad, which handles a heavy flow of transit freight. A heavy freight-moving density is also found on the Karaganda-Akmolinsk line. From Karaganda a heavy freight flow moves to the railroad junction of Sorokovaya (near Akmolinsk) on the South Siberian Railroad, and then to Akmolinsk, which is, after Petropavlovsk, Kazakhstan's second largest railroad center. From Akmolinsk, the greater part of the freight flow goes west to Kartaly and the lesser part north to Petropavlovsk. Except for the Omsk Railroad (part of the Trans-Siberian) and the South Urals Railroad (from Chelyabinsk southward), the Karaganda-Akmolinsk-Kartaly line has the heaviest freight density in Kazakhstan. Most of the freight is westbound, toward Kartaly. The Turkestan-Siberia Railroad and the Orenburg-Tashkent Railroad also have freight densities above the national average. On both lines the main freight flow is from north to south. However, while through freight plays a relatively minor role on the Orenburg-Tashkent line, it is quite important southbound on the Turksib Railroad. Timber moving from Siberia to Central Asia is the leading commodity on the Lokot'-Semipalatinsk-Alma-Ata section and the Arys'-Tashkent section. West of the junction of Berlik, where the railroad from central Kazakhstan joins the Turksib, southbound coal shipments are also important. The Arys'-Aktyubinsk railroad handles mainly diversified freight in both directions in contrast to the predominantly bulk commodities (coal, oil, timber, building materials) on the other lines of Kazakhstan.

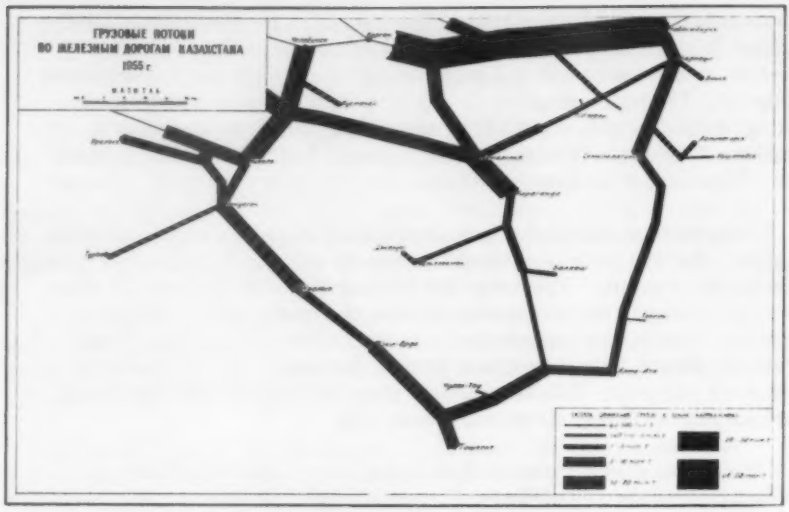

Fig. 1. Freight flows on railroads of Kazakhstan (1955)

Legend: Density of freight movements (lower right)

up to 500,000 tons (per year)
500,000 to 1,000,000 tons
1,000,000 to 5,000,000 tons
5,000,000 to 10,000,000 tons
10,000,000 to 20,000,000 tons
20,000,000 to 30,000,000 tons
more than 50,000,000 tons

The growth of coal shipments in the republic has resulted from the rapid development of coal mining. Coal production rose from 6,971,800 tons in 1940 to 17,364,200 tons in 1950, 27,973,900 tons in 1955 and 31,450,000 tons in 1956. Coal was mined in seven oblasts in 1956 (Karaganda, Pavlodar, South Kazakhstan, Akmolinsk, Aktyubinsk, Dzhambul and Gur'yev). The overwhelming share of the coal was mined in two districts -- Karaganda and Ekibastuz, both of national importance.

The railroad stations of Kazakhstan shipped more than 30 million tons of coal in 1956 (Fig. 2). Almost all the coal originated in seven large, specialized coal-loading stations. Five were located in the Karaganda basin: Karaganda-Ugol'naya (where almost half of all the coal originated), Bol'shaya Mikhaylovka, Karaganda-Novaya, Karabas and Nurinskaya. These five stations shipped 24.8 million tons. About 4.5 million tons originated at Ekibastuz and 600,000 tons at Lenger.

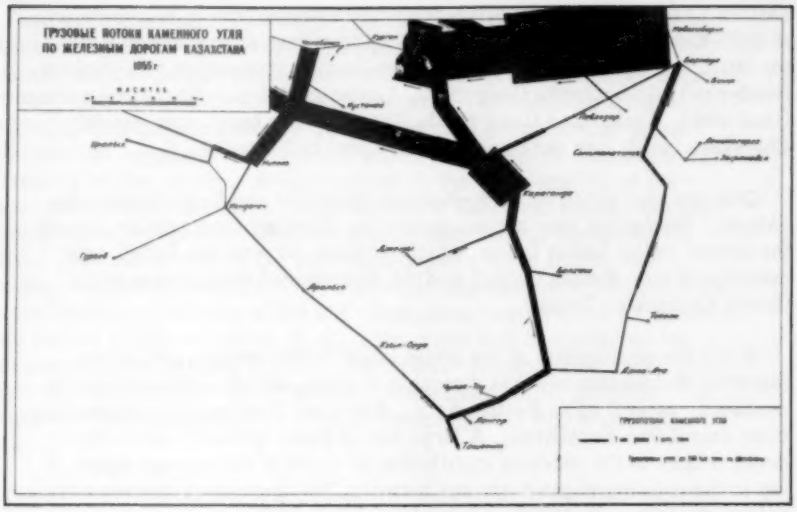

Fig. 2. Coal freight flows on railroads of Kazakhstan (1955)

Legend: Coal freight flows
(lower right) 1 mm equals 1 million tons per year
Flows of less than 500,000 tons
not shown

Most of the coal mined in Kazakhstan leaves the republic. In 1955, 65 per cent of all coal originating in Kazakhstan was destined for other republics. More than 92 per cent of the exports went to the RSFSR and 8 per cent to Central Asia. Out of the total amount shipped to the RSFSR, almost two-thirds went to the Urals. Some Kazakhstan coal also goes to Western Siberia, the Volga region and the European Center. Although exporting coal, Kazakhstan also receives coal from the Kuznetsk Basin, Eastern Siberia and Central Asia.

The main building materials carried by the railroads are ballast, building stone, sand, earth and clay (except refractory and molder's clays). Cement, lime and brick play a minor role.

Most of the outbound ore originates in Aktyubinsk Oblast. It is loaded at Nikel'-Tau and Kimpersay (nickel ore) and at Donskoye (chrome ore). The ore is shipped to the Urals, mainly to the Orsk smelter. In second place among the ore shipments is the nonferrous ore of central Kazakhstan. A large part is processed at local smelters, the rest is shipped to the Urals. The main ore-loading stations are: Dzhezkazgan (copper), Nel'dy (copper), Shortandy (gold), Makinka (gold), Dzhaltyr (gold; ore types added by Editor, S. G.) Nonferrous ores are also loaded in important amounts in

eastern Kazakhstan. That region ships concentrates both to local refineries at Ust'-Kamenogorsk and Leninogorsk and to refineries in Western Siberia, the Urals and the Ukraine. The main ore-loading stations are: Zyryanovsk (lead-zinc), Glubochanka (lead-zinc), Leninogorsk (lead-zinc), Predgornoye (lead-zinc), Zashchita I (lead-zinc), Zhangiz-Tobe (gold, rare metals), Charskaya (gold, rare metals; ore types added by Editor, S. G.).

Ores are also mined in Taldy-Kurgan, Dzhambul and South Kazakhstan oblasts. Nonferrous ores are shipped to the Chimkent lead smelter, one of the largest in the Soviet Union, which receives ore from the Tekeli concentrator (Taldy-Kurgan Oblast) and the Achisay and Mirgalimsay mines (South Kazakhstan Oblast).

Since the development of the virgin lands in the northern part of the republic, Kazakhstan now has a surplus of grain, which is shipped mainly westward, as well as to Central Asia. Grain and flour are also imported to some extent into Kazakhstan. A large part of these irrational cross shipments relates to the improper distribution of elevator and storage space, a lag in the building of grain-storage facilities and improper distribution of milling capacity. In 1955, for example, 180,000 tons of grain were shipped from Kazakhstan to the Ukraine, and 60,000 tons from the Ukraine to Kazakhstan.

A heavy flow of grain shipments moves westbound along the Trans-Siberian Railroad. Grain also moves from Akmolinsk to Petropavlovsk, to join the westward flow in the Trans-Siberian. Westbound grain also moves along the South Siberian Railroad. However, more important grain flows move from Siberia and eastern Kazakhstan to Central Asia.

Timber is mainly imported into Kazakhstan from Western and Eastern Siberia as well as from the Urals. Most of the timber is destined for Karaganda Oblast. The heaviest timber flow is westward along the Trans-Siberian. At Petropavlovsk, a large part of the flow is shifted southward along the line Petropavlovsk-Akmolinsk-Karaganda. Siberian timber also reaches central Kazakhstan along the South Siberian Railroad (Barnaul-Pavlodar-Akmolinsk). A major flow of Siberian timber moves along the Turksib Railroad to eastern and southern Kazakhstan as well as to Central Asia.

The total length of waterways in Kazakhstan was 5,678 km. in 1956, the Irtysh, Ural, Syr-Dar'ya, Ili, Lake Balkhash, the Ishim and the Karatal being used for navigation.

In the last few years of the Fifth Five-Year Plan (1951-55) and at the beginning of the Sixth (1956-60), the volume of waterway freight movements increased and a change in the freight turnover structure took place. Before World War II, wood products were the principal commodity moved along waterways in Kazakhstan; now these products, consisting mainly of firewood, occupy seventh place. Almost half of all the waterway freight now consists of building materials.

The Irtysh River serves Pavlodar, Semipalatinsk and East Kazakhstan oblasts, and maintains links with Siberia and China. At two points in Kazakhstan -- Semipalatinsk and Pavlodar -- the Irtysh crosses major railroads (the Turksib and the South Siberian). The favorable location of the Irtysh, from the point of view of transportation geography, in areas with important industries and farming, makes it possible to increase freight movements on that stream. A rapid current in the upper reaches of the Irtysh, where it crosses spurs of the Kalba and Narym mountains, requires the use of small barges and powerful tugs, thus adding to transportation costs. The construction of the Ust'-Kamenogorsk hydro station has improved navigation along the Altayskaya-Ust'-Kamenogorsk section. With the construction of the dam of the Ust'-Bukhtarma hydro station (in operation since August 1960 -- Editor, S. G.), the Irtysh will be converted into a deep waterway below Lake Zaysan. Above Ust'-Kamenogorsk, most of the freight moves upstream; below the city, downstream traffic prevails. The downstream flow increases in volume at Semipalatinsk, and especially at Omsk.

The second most important waterway of Kazakhstan is the Ural River. It flows over a distance of 1,100km. within western Kazakhstan. Its upper reaches above Ural'sk are little used for navigation because of sand bars. Shallow-draft vessels can regularly use the river between Ural'sk and Inder during the low-water stage. Barges of more than 200 tons can navigate on the Ural only during the high-water stage.

Out of total freight shipments of 125,700 tons along the Ural River in 1956, building materials accounted for 56,000 tons, chemicals (borates) 35,000 tons, wood products 19,700 tons (of which firewood 17,400 tons). Because of a lack of transfer facilities at Gur'yev, most of the borates destined for the Aktyubinsk chemical plant move upstream along the Ural. The firewood moves from Orenburg Oblast to West Kazakhstan Oblast.

The Ili River flows for a distance of 746 km. from the border of Kazakhstan to Lake Balkhash. Before World War II, only the section between the town of Ili and the Chinese border was used for navigation. Since the war irregular shipments are also made in the lower reaches from Bakanas to Ili, mainly saxaul wood. The freight moving from Ili town upstream to the Chinese border consists mainly of chemicals, oil, cement and grain.

Navigation on Lake Balkhash is of local importance in the western part of the lake, between Bertys Bay (Balkhash city)and Karachagan (318 km.), for sulphates and coal.

Small shipments are made along the Syr-Dar'ya, mainly saxaul, and along the Karatal and the Ishim. Caspian Sea traffic plays a relatively small role in the transportation of Kazakhstan. Before World War II outbound freight on the Caspian exceeded inbound shipments. Outbound shipments include oil, ores and fish. Gur'yev receives timber, building materials, salt and grain by sea. On the Aral Sea there is a regular service between Aral'sk

and Muynak (in the Kara-Kalpak ASSR). Southbound shipments predominate.

In terms of freight tonnage carried, trucking is in first place among the means of transportation of Kazakhstan. The amount of trucked freight exceeds by 2.3 times the outbound and inbound tonnage carried on the railroads of Kazakhstan. However the average length of haul by trucks is only 16.2 km. in Kazakhstan.

Three types of transportation centers are distinguished in Kazakhstan: (1) railroad-transit centers; (2) railroad-truck transfer centers, and (3) railroad-waterway transfer centers.

1. The largest transport hubs are railroad-transit centers situated at the crossing of major railroad lines. Transit freight accounts for the dominant part of the operations of such centers. There are six such stations: Sorokovaya (near Akmolinsk), Zharyk, Berlik, Lugovaya, Arys' and Kandagach. The largest are: Sorokovaya, Arys' and Zharyk. All these railroad transit stations lack highway connections and are not situated in large cities or industrial centers. Local freight turnover plays a small part in freight operations, with inbound freight exceeding outbound shipments.
2. There are three types of railroad-truck transfer centers: (a) a railroad center combined with a network of major highways; (b) large railroad stations on trunk lines with industrial spurs and highway connections; (c) railroad stations with a network of connecting highways.

(a) The first type includes oblast capitals with major railroad stations, such as Petropavlovsk, Akmolinsk, Dzhambul and Kustanay. These stations are characterized by a large percentage of transit freight and an excess of inbound over outbound freight. Petropavlovsk and Akmolinsk are Kazakhstan's largest transportation centers. The transportation facilities serve the population of each city and its industrial plants. National, republic and local highways are used for carrying goods to Petropavlovsk and Akmolinsk for processing, storage and further shipment by railroad. In both centers, grain dominates among outbound goods, and coal, building materials and timber among inbound goods.

The Dzhambul transportation center, although handling a far smaller amount of freight than Petropavlovsk and Akmolinsk, and having a lower traffic density on its approaches, is also characterized by a dominance of transit freight (95 per cent of all operations). Inbound freight by rail and road greatly exceeds outbound shipments. Dzhambul is distinguished by the large volume of inbound sugar-beet shipments for processing at the local refinery.

The Kustanay center still lacks an important transit traffic, inbound and outbound freight being far more important. Inbound freight exceeds outbound shipments both on railroads and in trucking. The principal inbound goods are: building materials, coal and timber (by rail) and grain (by truck). With the development of iron mining at the nearby Sokolovka-Sarbay combine

(at the city of Rudnyy), iron-ore transit shipments through Kustanay will begin to exceed the local freight turnover (inbound plus outbound freight). With completion of the South Siberian Railroad, transit traffic through Kustanay will increase even further. Seven major highways radiate from Kustanay; these highways carry heavy traffic but still require improvement.

(b) Among the major transportation centers of Kazakhstan situated on trunk railroads, Karaganda stands out not only by its large outbound shipments, far exceeding inbound traffic, but also by the coal-loading specialization of the stations making up the Karaganda railroad hub. Because of the scattered nature of the Karaganda urban area, comprising 50 distinct population centers, the city's railroad operations are not concentrated in a compact area, but are scattered among several stations, specializing in passenger, freight or service operations and linked by a large network of spurs and service lines totaling 300 km. The Karaganda-Sortirovochnaya station, situated on the main line, classifies and forms trains out of cars arriving from the mines and plants of Karaganda and other areas.

Karaganda is also reached by roads, mainly dirt roads, from Temir-Tau, Karkaralinsk, Balkhash, Dolinskiy and Tokarevka, but these roads do not carry heavy freight traffic on the approaches to Karaganda. Most of the truck transportation is within the city, linking individual settlements with mines, plants, railroad stations and other city points.

The Alma-Ata transportation center is distinguished by its great diversity of functions. Railroad transportation here is linked up with the transportation services of the greater Alma-Ata area, which has wide-ranging interregional trucking connections. Alma-Ata has two railroad stations: Alma-Ata I, on the Turksib Railroad, and Alma-Ata II, on a 9-km. spur of the Turksib. Alma-Ata I is essentially a transit station, but also handles outbound and inbound freight and passengers. The local freight turnover of Alma-Ata II is twice that of Alma-Ata I (in terms of outbound and inbound freight). At both stations inbound freight exceeds outbound shipments, which is typical of any large city with a manufacturing industry.

(c) Large railroad-truck transfer centers supplied with a network of connecting highways are Kokchetav, Atbasar and Aktyubinsk (Fig. 3). In all three, inbound traffic exceeds outbound shipments.

3. The railroad-waterway transfer centers are Semipalatinsk, Ust'-Kamenogorsk and Pavlodar. Semipalatinsk and Ust'-Kamenogorsk consist of several railroad stations and river landings specialized in various transportation operations.

The location of Kazakhstan from the point of view of transportation geography and the rapid growth of its productive forces have led to the construction of a new railroad network (Fig. 4).

The construction of a network of narrow-gauge and broad-gauge railroads

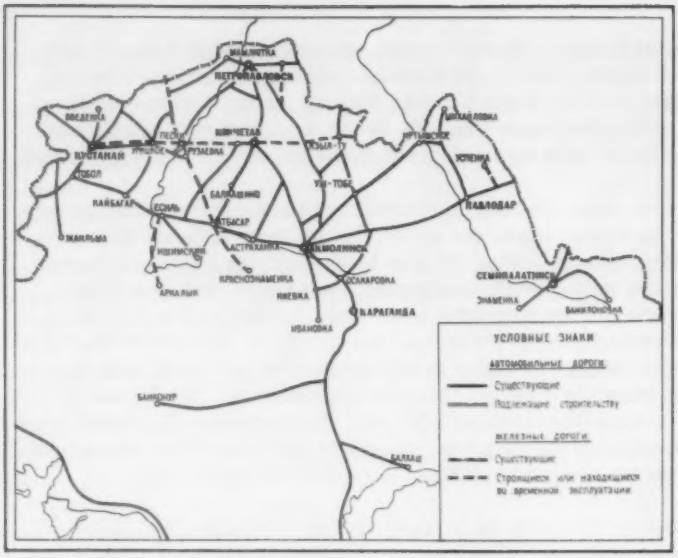

Fig. 3. Highway network on the virgin lands

Legend: (Lower right)
Highways
Existing
Planned
Railroads
Existing
Under construction or in temporary operation

began in northern Kazakhstan in 1954 to handle the large amount of grain grown in the newly developed virgin lands. The operation of narrow-gauge lines in Kazakhstan turned out to be of limited usefulness. Part of the planned narrow-gauge grain carriers, already under construction, was converted to broad gauge. The reconstruction of certain lines to broad gauge will yield the new Middle Siberian Railroad, 1,040 km. long, through Kustanay-Kokchetav-Kaymanachikha-Karasuk. At Karasuk, the new trunk line connects with the line joining Barnaul with Kamen' on the Ob' River. This will result in a new outlet from the Kuznetsk Basin to the southern Urals, easing some of the heavy traffic load of the Trans-Siberian, which carries coal from the Kuznetsk Basin to the southern and middle Urals. The Middle Siberian Railroad, passing through the center of the virgin lands, will also serve the large agricultural economy developing there.

The Kustanay-Tobol line serves the Sokolovka-Sarbay iron-mining district. The line is being extended to Dzhetygara, where a new asbestos-mining center is under construction. Another new line, from Yesil' to

Arkalyk, 227 km. long, will handle bauxite shipments from the new KT Turgay deposit.

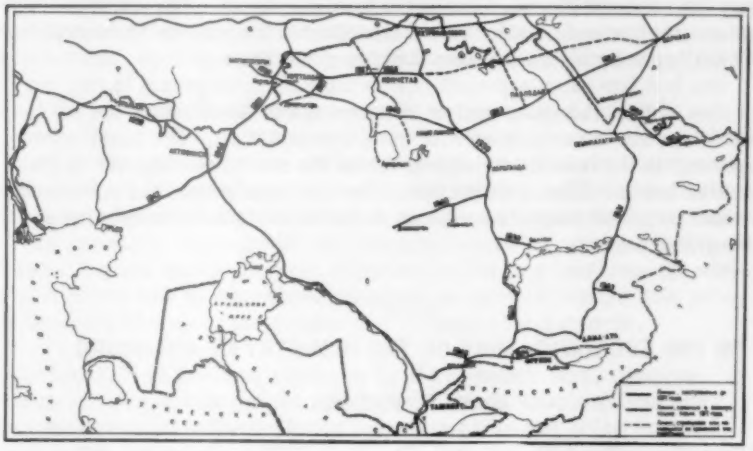

Fig. 4. Development of the railroad net of Kazakhstan

Legend: (lower right)
- Lines built before 1917
- Lines opened after 1917
- Lines under construction or in temporary operation
- Years of completion shown

In southern Kazakhstan construction is being completed on the railroad from Aktogay to the Chinese border at Druzhba (312 km. long). This line goes from Aktogay on the Turksib Railroad through the Balkhash-Alakul' lake depression to the Dzungarian Gate on the Chinese border, where it will join up with a railroad going to Lanchow. Future plans are for extending the railroad from Aktogay westward to Karaganda, thus establishing a direct link between China and the industrial districts of central Kazakhstan and the Urals.

The railroad between Ekibastuz and Kulomzino (a station of Omsk) will shorten the haul between the Ekibastuz coal basin and the Omsk industrial node by 410 km. compared with the former roundabout coal haul through Kulunda and Tatarsk. The new line will also be used for grain hauls.

Of possible importance in the future could be a railroad link between the Dzhezkazgan industrial district of central Kazakhstan and the Urals. Such a link would call for the construction of two lines: Dzhezdy-Arkalyk,

260 km., connecting two present spur lines, and Amankaragay-Kustanay, 100 km. The construction of these two lines would shorten the haul from Dzhezdy (a manganese producer -- Editor, S. G.) through Arkalyk-Yesil'-Amankaragay-Kustanay to Chelyabinsk by 770 km. compared with the present haul through Zharyk-Akmolinsk-Tobol-Kustanay. The projected Amankaragay-Kustanay section would also shorten the haul for steam coal from the Ubagan basin to the power stations of the Urals.

In view of the inadequate system of waterways in Kazakhstan, the railroads operate in conjunction with truck transportation. The construction of highways in the republic is lagging behind the rate of development of its productive forces. Slow construction, drawn out over years, and a scattering of investments over many road projects do not result in rapid completion of road-building projects.

ON THE ECONOMIC LINKS OF THE INDUSTRY OF ORENBURG

By V. S. Varlamov

(From Geografiya i Khozyaystvo, No. 3-4, 1958, Pages 64-70)

A geographical analysis of the economic links of industry is an important aspect of urban studies. Such analysis makes it possible to determine how one of the main factors of urban development -- the city's economic-geographic location -- affects the entire economic structure of the city and the relationships and development of its functions. Such analysis also shows the tendencies of development of the city in terms of the potentialities provided by its economic-geographic location.

A geographic study of economic links, besides its scientific interest, is now also of practical interest. In the fight against manifestations of the anti-state practice of localism in industry and construction, we must not simply retain existing economic links in unchanged form, but rationalize such links, especially those of individual industrial nodes and centers. This is especially important for cities whose industry developed basically because of their favorable economic-geographic location. One such city is Orenburg.

Orenburg is a large industrial center of the Urals that developed especially rapidly during World War II and the post-war period. In 1956 the gross value of industrial output of Orenburg exceeded the 1940 level by 5.3 times and amounted to almost 2.5 billion rubles, while the number of industrial workers doubled during that period and amounted to 28,000.

The main industries of Orenburg are: (a) machine building, which together with metal fabrication occupies 37.9 per cent of the industrial workers and accounts for 23.5 per cent of the gross value and 42.2 per cent

of the net value of the city's industrial production; (b) light industry (textiles, garments, shoes), with 33.8 per cent of the workers, 35.5 per cent of the gross value and 22.2 per cent of the net value of industry; (c) food and feed industry, with 11.6 per cent of the workers, 28.9 per cent of the gross value and 22 per cent of the net value of industry. Of growing importance in Orenburg's industry are branches with a national specialization, such as oil refining and reclaimed rubber (they account for 4.8 per cent of the workers, 5.8 per cent of the gross value and 6.9 per cent of the net value of industry.)

Most of the city's industries are supplied with long-haul raw materials and oriented toward distant markets. Machine building, oil refining, rubber reclaiming, textile and garment factories are based almost entirely on long-haul raw materials. Even traditional Orenburg industries, such as flour and groats milling and mohair knitting, which originated on a local raw-material base, must now rely to a considerable degree on material brought from outside Orenburg Oblast, in some cases over considerable distances.

The "market" of Orenburg's industry is of tremendous size, covering either most of the territory of the USSR (for example, Orenburg flour and groats are consumed in the Urals and the entire Asian part of the Soviet Union) or the entire country (for example, in the case of machine building, oil refining, except for the production of cup grease, and in the case of the rubber-goods, silk, mohair and feed industries) or even the entire Socialist camp.

Such long-distance economic links result mainly from the fact that, in contrast to the large industrial centers of the eastern Urals, such as Nizhniy Tagil, Magnitogorsk, Orsk and Novotroitsk, based on local high-grade mineral resources, the industry of Orenburg developed on the basis of the city's economic-geographic location.

The economic-geographic location of Orenburg has four general aspects that played a role in the formation of the city's industry: (1) its location between the eastern regions (Urals, Siberia, central Kazakhstan, Far East) and the European part of the USSR (mainly the Central Industrial and the Volga regions); (2) its location between the European part of the country (Central Industrial, Northwest and Volga regions) and Central Asia with western and southern Kazakhstan; (3) its location between the Urals and Central Asia with western and southern Kazakhstan; (4) its location with respect to a local agricultural base and with respect to markets for farm-based products. (The four aspects are illustrated by four generalized co commodity flow charts that could unfortunately not be reproduced here -- Editor, S. G.)

It is typical of most of Orenburg's industries that they represent a sort of middleman in the inter-regional division of labor and in the commodity exchange between areas situated on opposite sides of Orenburg. The regions listed above represent paired groups of regions linked by the

shortest route through Orenburg. These regional groups are: (1) the eastern and European regions; (2) the European and Central Asian-Kazakh regions; (3) the Urals and the Central Asian-Kazakh regions.

Having received raw materials and semi-finished goods from one side of such a regional pair, Orenburg's industry then markets the finished product on the other side.

For example, the metal-fabricating industry of Orenburg developed on the basis of using the city's location on one of the routes from Urals steel centers, specifically Magnitogorsk, to European Russia. (Magnitogorsk steel follows two routes to European Russia: a northern route through Kartaly-Chelyabinsk-Ufa and a southern route through Kartaly-Orsk-Orenburg. Orenburg is also situated on another steel-flow route, from the Novotroitsk steel mill to European Russia. But Orenburg makes little use of the natural-alloy steel of Novotroitsk; its machine-building industry requires mainly ordinary steels.) In 1955 the stations of the Orenburg railroad hub received 84,400 tons of pig iron, steel ingots and rolled products. Of that amount, 76 per cent arrived from the east, i.e., the Urals and partly the Kusnetsk Basin, 13 per cent from southern European Russia, and 11 per cent from the Central Industrial Region.

Most of the machinery made from Urals iron and steel is shipped westward, to European Russia. (The share of the European Russian market, without the Urals, of the Gidropress and Metallist hydraulic-press plants of Orenburg is, respectively, 72.2 and 72.6 per cent; the European market share of the drill-manufacturing plant is 73.7 per cent, of the lathe factory 61.1 per cent, and of the Avtozapchast' factory, making tractor and combine parts, 69.2 per cent.) This is due largely to the fact that most of Orenburg's machinery products (lathes, hydraulic presses, drills, tractor and combine parts) are intended for consumption by industry and the European part of the country contains most of Soviet industry (it accounts for 84 per cent of Soviet industrial output).

The output of Orenburg's machine-building industry also goes to other regions of the USSR. Such a broad market results from three factors: first, the specialization of the city's plants in products that are produced little or not at all elsewhere in the USSR; second, the production of the city's machinery and metal-fabricating plants is of a character required by a diversified range of industries, transportation and agriculture; and third, the low level of integrated development of the city's industry and the relative youth of its heavy industry.

The economic links of Orenburg's oil-refining industry, the oil and lubricants factory, are also quite rational. Those refined products for which raw material is received from the west, i.e., the European oil areas of the USSR, are marketed in the east, in Siberia, Kazakhstan and Central Asia. This applies to cup grease and other lubricants (except leather and textile greases). On the other hand, products for which raw material is received

from the Asian regions are marketed in the west, the European part of the country. That is the case with wax products made from Central Asian ozocerite, such as ceresin and ceresin and ozocerite mixtures. The oil-refining industry thus fully utilizes the city's economic-geographic location. In fact, the shortest route from the Volga-Urals oil area to Kazakhstan and Central Asia goes through Orenburg, and the rail route from the Groznyy oil fields to Kazakhstan and Central Asia passes through Sol'-Iletsk, 80 km. from Orenburg. In addition Orenburg is situated on the main route from Central Asia, chief producer of ozocerite, to European Russia, the chief consumer of ozocerite and ceresin products.

The long inter-regional links of most of Orenburg's industries, caused by the "middleman" nature of these industries, are necessary and inevitable to the extent that inter-regional exchange in general is necessary and inevitable and particularly between: (a) the eastern and European regions of the USSR, (b) the European and the Central Asian-Kazakh regions, and (c) the Urals and the Central Asian-Kazakh regions.

Besides these necessary and rational links, Orenburg's industries are also involved in many irrational inter-regional exchanges, caused by the following factors: (1) lack of connection between the character of production of a given plant and local consumption needs, local raw-material resources or the economic-geographic location of the city; (2) a low degree of industrial integration among industries within the city; (3) improper planning, resulting in particular from the system of industrial management by industrial ministries; (4) the large role played in Orenburg by plants evacuated from European Russia during World War II.

The effect of the first factor can be illustrated by Orenburg's-rubber reclaiming plant. (Rubber is reclaimed from scraps, such as worn tires and tubes, and is used for the manufacture of various rubber goods.)

The rubber-reclaiming plant lacks both a raw-material base and a market in Orenburg or in Orenburg Oblast. (A large part of the rosin required for the reclaiming process is shipped from Altay and Krasnoyarsk krays and Irkutsk, Gor'kiy, Tomsk, Sverdlovsk and Amur oblasts. As far as the tire scraps are concerned, they are available anywhere and Orenburg has no special advantages in that respect.) Nor does Orenburg lie on routes connecting areas rich in rubber scraps with large consuming areas of reclaimed rubber, such as tire factories or rubber footwear factories.

The situation gives rise to a whole system of irrational hauls. More than half of the scrap tires arrive from Kuybyshev. More than 60 per cent of the reclaimed rubber is returned to the Middle Volga region and goes beyond to other parts of European Russia. Almost 14 per cent of the rubber scrap arrives from Siberia and the Soviet Far East, and about the same percentage of the reclaimed rubber is returned to those areas, in other words, all the rubber shipped from Siberia and the Far East is returned to those areas. These are not only cross hauls, but long-distance cross hauls, resulting in

additional transportation costs. A carload of scrap tires is worth about 7,000 to 12,000 rubles at the loading point, and the shipping cost from Vladivostok or Nakhodka to Orenburg is 60,000 rubles. In short, most of the reclaimed rubber is sold in areas that furnish the scrap or is shipped back through those areas.

The irrational marketing system of the rubber-reclaiming plant is also related to the inadequate integration of Orenburg's industry. If a large consumer of reclaimed rubber, such as a tire plant or a rubber-footwear plant, were established locally -- in Orenburg itself or in the oblast -- local consumption of reclaimed rubber would increase markedly and the plant's marketing system would become more rational. The situation is already beginning to improve somewhat in connection with the introduction of rubber-goods fabrication at the rubber-reclaiming plant and the prospective conversion of the reclaiming plant into a fabricating plant. (In the next two to three years rubber fabrication is to be sharply expanded, while the present level of reclaimed-rubber output will be maintained. Until now the fabricating department has used only 50 to 100 tons of reclaimed rubber out of the plant's total output of 1,200 to 1,300 tons a month.)

From the viewpoint of developing an integrated industry and reducing long inter-regional hauls, it would also be desirable if a plant producing hydraulic apparatus and instruments for hydraulic presses were established in Orenburg. (At present these components must be ordered from Moscow, Leningrad, Khar'kov, Yelets and elsewhere.)

From the same point of view it would be important to stop ordering rubber components for the Orenburg footwear industry from the Kiev rubber-reclaiming plant and to start making these components at the Orenburg reclaiming plant, counting on a future increase of production at Orenburg.

As for irrational marketing of the production of Orenburg's flour and groats milling and feed industry, that is the result of improper planning.

On the basis of a bureaucratic system of cost calculation adopted by the city's flour mills, which does not include transportation costs, the milling capacity at Orenburg was increased excessively (up to 1,000 tons a day in 1956), exceeding both the local raw-material base and local flour needs.

An analysis of data for the last eight years (1950-57) shows that only in 1950, 1953, 1954 and 1956 would Orenburg Oblast have been able to supply fully all flour mills with grain. But since not all the marketed grain is processed in local flour mills (some of it is shipped out of the oblast or used for other purposes), the local flour mills are not adequately supplied with local grain and additional grain must be imported from other oblasts and republics. Even in the record crop year of 1956, Orenburg's flour mills were supplied only two-thirds by local wheat and one-third by wheat shipped from other parts of the country. At the same time a large part of the local wheat was shipped out of the oblast.

Orenburg's flour mills produce about 4 to 4.5 times more flour than is needed by the population of Orenburg and of the other urban centers of the central and eastern parts of the oblast (Orsk, Novotroitsk, Mednogorsk, Kuvandyk and their workers' settlements). A large flour surplus is therefore available for shipment elsewhere.

In 1956 only 19.6 per cent of the flour was consumed in Orenburg city and an additional 19.5 per cent in the rest of the oblast. The remaining 60.9 per cent, or 125,600 tons, was shipped out of the oblast. It traveled westward as far as the Central Industrial Region and eastward as far as Sakhalin and Kamchatka.

In bringing in tens of thousands of tons of grain from remote areas and shipping out the milled product, the Orenburg mills produce considerable double hauling. In addition, many of these hauls, being already irrational as double hauls, are also cross hauls.

In 1956, for example, the Orenburg mills received 48,100 tons of wheat from Siberia and Kazakhstan. These and other areas of Siberia, the Far East and Central Asia received 112,500 tons of flour, or 54.6 per cent of the entire output of the Orenburg mills. European Russia sent to Orenburg 48,500 tons of grain, which was hauled against the rational flow of grain out of the east. Orenburg shipped to European Russia 5,600 tons of flour.

According to our calculations, the total transportation expenses of the Orenburg mills in shipping in grain from outside the oblast and shipping out flour amounted to nearly 24.4 million rubles in 1956, which is almost equal to the total cost of the mills themselves. At the same time the mills' books for 1956 showed a profit of 14.08 million rubles (not counting transportation expenses). In other words, the transportation costs not only ate up the profit, but exceeded that profit by almost 75 per cent. (In poor crop years, such as 1955, the losses of the Orenburg mills are even greater, as shown by the study of the Institute of Complex Transportation Problems of the Academy of Sciences USSR titled Ratsionalizatsiya perevozok khlebnykh gruzov i razmeshcheniya mukomol'noy promyshlennosti i elevatorno-skladskogo khozyaystva (Rationalization of the transportation of grain and of the distribution of the milling industry and elevator and storage facilities), 1957, prepared under the supervision of I. I. Belousov. Our calculations of the transportation expenses for 1956 are based on the method used in that study. The main results of the study are published in I. I. Belousov's pamphlet Mezhrayonnyye svyazi i perevozki khlebnykh gruzov (Inter-regional links and grain transportation), Moscow, 1958.)

A similar situation exists in the groat and feed industry of Orenburg. True, the share of local grain processed by the groat mills is greater than the share of local grain processed by the flour mills. (In 1956 Orenburg Oblast supplied the groat mills with 80.8 per cent of their proso millet requirements.) The marketing of groats suffers from fewer cross hauls,

but only 1/10 of the milled millet is marketed locally, in Orenburg or in the oblast. The eastern regions absorb almost three-quarters of the production, remote areas taking an especially large share. The Kuznetsk-Altay region (it is 2,286 km. from Orenburg to Novosibirsk) takes 24.8 per cent; the Far East (it is 8,274 km. from Orenburg to Vladivostok) 26.3 per cent; Middle Siberia (Orenburg-Krasnoyarsk 3,047 km.) 9.3 per cent, and Eastern Siberia (Orenburg-Irkutsk 4,126 km.) 8.8 per cent.

The Orenburg feed plant, the largest in the Soviet Union, receives more than half of its raw material from outside the oblast, and ships more than 80 per cent of its output far outside the oblast. In 1956, for example, the plant received 15,400 tons of grain and 39,700 tons of bran from the European part of the USSR (the Central Industrial Region, the Ukraine, the Northern Caucasus and even Transcaucasia). A total of 89,500 tons of feed was shipped to European Russia. The Eastern regions of the USSR supplied the plant with 25,000 tons of grain and 2,000 tons of bran, and received in return 44,500 tons of feed.

The main reason for that situation is the tremendous increase in the capacity of the feed plant. When it was first built in 1931-34, its annual production plan of 7,000 to 8,000 tons of concentrated feed was fully supplied by local raw material. Now that the annual production plan has reached 300,000 tons (1957), i.e., by 38 to 43 times more than the original capacity, local raw material is inadequate, and local consumption absorbs only one-fifth of the annual feed output.

A major role in Orenburg's industry is played by evacuated plants that before World War II were connected neither with one another nor with the older Orenburg plants. (In 1956, the evacuated plants accounted for 37.3 per cent of the gross value of output, 35.8 per cent of the labor force, and 41.1 per cent of the fixed capital of Orenburg's industry.). Those plants arose as part of the development of the areas in which they were situated and were linked with other plants in more or less integrated complexes. It is understandable that their evacuation to Orenburg destroyed their previous links and required the establishment of new links. Some plants, for example, the machine-building plants, became "acclimatized" in their new surroundings and established new supply and market connections based on their new location. Other plants, such as the textile mills, found neither spinning nor finishing facilities in Orenburg and were forced to retain their old connections, producing in many cases irrational hauls. Orenburg should add spinning and finishing mills and become an integrated textile center because the city's location on the textile fiber route to the Urals would seem to favor its becoming a major center supplying the Urals with textiles.

The principal ways of rationalizing inter-regional links and other economic links of Orenburg's industry are the development of an integrated industry, consideration of the city's economic-geographic location (present and future) and adjustment of plant capacities to local resources and needs.

COMMENTS ON V. S. VARLAMOV'S ARTICLE "THE ECONOMIC LINKS OF ORENBURG'S INDUSTRY"

By V. L. Lyul'kin

(From Geografiya i Khozyaystvo, No. 6, 1960, Pages 32-33)

V. S. Varlamov's article examines among other questions the position of the food-processing industry, which accounts for 28.9 per cent of the gross value of Orenburg's industrial output. The author is correct in noting that a geographic study of economic links, aside from being of scientific interest, has now also acquired practical interest. The importance of the questions raised by Varlamov for practical workers is evident simply from the fact that after having heard about the article, the Minister of Grain Products RSFSR gave instructions to the appropriate departments of the ministry to study the article, to eliminate excessively long hauls within the next few years and to provide in the Seven-Year Plan for a rational distribution enterprises of the flour-milling, groats and feed industry.

However, while correctly posing the questions relating to the distribution of enterprises of that industry and noting irrational and cross hauls, the author of the article did not take account of many factors closely related to that problem and directly affecting the present marketing conditions. For example, one must bear in mind the geography of the grain harvest. In 1956, as the article correctly notes, Orenburg Oblast had a very good grain crop, which made it possible not only to meet fully the needs of the processing industry within the oblast but to ship 1,281,000 tons of grain out of the oblast. In 1957, a less favorable crop year, Orenburg Oblast, on the other hand, had to import (especially in the second half of the year) more than 500,000 tons of grain, mainly from Siberia.

The article correctly notes that in good crop years the amount of grain available to the state is adequate to fully supply all flour mills. Then it adds that since not all the available grain is used for processing, the actual supply for the Orenburg mills is inadequate, requiring the importation of grain from other oblasts and republics. To support that statement, the author notes that even in the record year of 1956, the Orenburg flour mills filled only two-thirds of their needs from local grain and one-third from out-of-oblast grain. That statement is, to say the least, imprecise. The 1956 crop gave grain only starting in August, and before August out-of-state grain had to be imported because of the poor 1955 crop. Besides, the existing flow routes of grain must be borne in mind. All grain-collecting points situated west of Orenburg and those situated along the Ufa Railroad ship their grain westward in accordance with the prevailing flow lines. That grain could not be shipped to the Orenburg mills and therefore it happens that Orenburg Oblast exports grain westward while supplying the Orenburg mills with out-of-state grain from the east along the prevailing westward flow route. Without taking account of that factor, the analysis is incomplete and does

not correspond to the existing production links. It must also be borne in mind that the quality and varieties of grain needed for the making of flour and groats (especially the better grades) are of major importance in the baking industry. They depend on the producing areas and on the harvesting conditions, which vary by years and may require long hauls and sometimes even cross hauls.

It is evident from the foregoing that the raw-material base of flour and groats mills and feed factories change from year to year in accordance with the geography of the harvest, the quality and assortment of the grain available to the state, and that all these factors affect the production cost; the nature of the hauls (long hauls, cross hauls) and therefore the transportation costs. Research into the operations of industry that does not take account of these factors is devoid of all practical interest and misleads the reader.

Probably the most important question raised by Varlamov is contained in his statement that flour mills use a bureaucratic system of cost calculation without counting transportation costs, which led, in particular, to a situation in 1956 where the transportation costs of the Orenburg mills not only ate up the mills' profits but exceeded the profits by almost 75 per cent.

Is that system really as disgraceful as Varlamov makes it out? Sure, it is true that production costs of flour, groats and feed are not calculated in the milling industry in the same manner as in other industries. The existing system, or the adopted system, as the author calls it, resulted from the fact that all grain marketing in the Soviet Union is handled by a single organization. In view of the lack of permanent supply connections between mills and grain producers, depending on the harvests and the quality and assortment of grain in various regions, the cost of grain including transportation costs would fluctuate because of these factors. The same mills in Orenburg that would have been in a favorable situation in 1956, when local grain supplies were adequate, would have suffered great losses in 1957, when grain had to be obtained from far away.

The milling industry forms part of a single grain-marketing organization. According to the procedure long in effect within that organization, the purchase price of grain paid by the mills includes a transportation cost based on the average nation-wide expenditures on grain transportation. These transportation expenses are thus included in the total production cost of flour, groats and feed. If the operations of individual plants are analyzed under such a system, as was done in the article under discussion, the production cost appears to be distorted, but from a purely economic, nation-wide viewpoint, the cost of that type of commodity is correctly reflected and the over-all results take full account of the transportation costs of both the raw material and the finished product.

An analysis of this question merely from the point of view of one plant or a group of plants, as in the case of Orenburg, does not prove anything.

A more detailed discussion of the problem of distribution of mills -- whether to locate them in the producing areas or in the consuming areas of flour, groats and feed -- must be the subject of thorough research taking account of the existing distribution of the industry, the geography of harvests and the quality and assortment of grain made available to the state.

GEOCHEMICAL PRINCIPLES OF LANDSCAPE CLASSIFICATION

By A. I. Perel'man

(From Vestnik Moskovskogo Universiteta, seriya geografiya, 1960, No. 4, Pages 3-12)

Landscape classification is one of the current scientific problems whose solution may help in working out other theoretical and practical problems in geography. (The author supports the typological concept of the term "landscape" and does not regard it as a synonym of "physical-geographic area," as some geographers do.) It seems to us, in particular, that the difficulties and differences that arise in physical-geographic regionalization and the compilation of landscape maps can be explained to a large degree by the lack of a generally accepted scheme of landscape classification. One of the ways of constructing such a classification is through the use of geochemical methods. This paper is concerned with the statement of some geochemical principles of landscape classification.

Any classification is based on given features of the study objects. It is therefore necessary to establish, first of all, the taxonomic significance of individual geochemical features and properties of a landscape, i.e., which are the principal and the secondary characteristics of the landscape, which are to be used for delimiting large taxonomic units (types, classes) and which for small units (genera, species), and, finally, which should be entirely ignored in classification.

1. Systematic and nonsystematic features.

Every landscape contains a large variety of properties and features, among which, for classification purposes, we must distinguish systematic and nonsystematic (individual) features.

Systematic features are those common for many landscapes. Such features are important for geochemical (or any other kind of) classification. Therefore a geochemical classification of landscapes must be based on systematic features.

The study of individual (nonsystematic) features is also of theoretical and practical importance. That is evident from the experience of both geography itself and many other natural sciences. In other words, many sciences distinguish species (a systematic unit) and individuum.

Similar subdivisions exist in geography. Physical geographers have long accepted the concept of a concrete geographic individuum with all its

specific characteristics (L. S. Berg and others). Such a geographic individuum is unique just as there are no two entirely identical animals, plants or minerals. Continuity in space is typical of a geographic individuum.

The identification of geographic individua characteristic of a given area is called regionalization of the given area. This is one of the basic problems of landscape studies, to which much attention has recently been devoted by Soviet scientists (D. L. Armand, N. A. Gvozdetskiy, Yu. K. Yefremov, A. G. Isachenko, N. I. Mikhaylov, F. N. Mil'kov, Yu. P. Parmuzin, N. A. Solntsev, I. S. Shchukin and others). A special type of regionalization is geochemical landscape regionalization, the methodology for which has not yet been adequately worked out.

The geographic individua may be of various orders -- rayons, oblasts, countries, continents and so forth. The study of geographic individua is especially important from the practical point of view because economic measures must be based on the concrete characteristics of a locality. Unfortunately the question of geographic individua has not been adequately worked out from the geochemical point of view although we have no doubt that there are many "unique" geochemical characteristics that can be found only in given concrete geographic areas, provinces or countries. These features must be studied, they are of great practical importance, but such study is not part of the systematic work on landscapes.

2. Widespread and rare landscapes.

The nonsystematic features include, in particular, the degree of occurrence of landscapes and their area. For this we also find an analogy in the classification of other natural objects, such as plants, minerals and soils. In each case the classification is based on properties of the object itself, and never on its geographical distribution or numbers. Therefore a given taxonomic unit (say, a type or class) may include both widespread landscapes forming entire zones on the earth's surface, and relatively "rare" landscapes, found only in a few regions and covering a small area (but having a rather sharply expressed distinctiveness).

For example, from the point of view of geochemical classification, the tayga (northern forest) landscape type would include both the widespread class of acid tayga landscapes, covering most of the tayga zone, and the rare sulphate class, which is found only on pyritized rocks and sulphide ore bodies.

Until now geographers have devoted most of their attention only to widespread "typical" landscapes. The time has now come to study also the rare "nontypical landscapes" just as the geologist, for example, studies rare minerals and the biologist rare plant and animal species. Aside from its great theoretical importance, such study is also important from a practical point of view because the "nontypical" rare landscapes include, for example, many mineral deposits, health resorts, and so forth.

3. The major systematic landscape features. Principal and secondary elements.

The systematic landscape features include the migration of chemical elements because such migration determines the basic geochemical characteristics of landscapes.

Let us recall that solar energy brings about the migration of chemical elements of the atmosphere, hydrosphere and lithosphere over the earth's surface. Such migration results in changes in parts of the geographic envelope; these parts penetrate one into the other, giving rise to separate natural bodies, such as living organisms, soils, eroded earth's crust and natural waters, all of which enter into complicated relationships. This gives rise to the formation of separate natural complexes, whose components (soils, eroded earth's crust, organisms) are closely interconnected by the migration of atoms. These complexes have been called natural landscapes. The constant influx of solar energy brings about a tremendous diversification and dynamism in the migration of atoms in landscapes, and the absence of equilibrium: the atoms are in constant motion. This is a characteristic of landscapes and an essential condition for their existence. In other words, a landscape is a dynamic system that is not in equilibrium and possesses large amounts of free energy. In emphasizing the importance of the migration of elements in the formation of landscapes, B. B. Polynov (1946) introduced the concept of geochemical landscape -- a section of the earth's surface distinguished by certain migration characteristics. It is obvious that the migration of elements should also be the basis of a geochemical classification of landscapes.

Nearly all the chemical elements of the periodic system migrate within the landscape, but not all play an identical role. In general the elements that predominate within the earth's crust as a whole also predominate in the landscape, and a very uneven distribution of individual elements is also typical of the landscape.

We can distinguish principal elements, whose average content in the rocks, soils waters and organisms exceeds 0.01 to 0.1 per cent, for example, O, Si, Al, Fe, Ca, Na, K. Mg, C, H, N, S, P and Cl. These elements make up about 99 per cent of the total mass of the landscape and determine its main geochemical characteristics. They are, so to say, "geochemical dictators" and determine the physical and chemical conditions of the environment, including the conditions of migration of all other elements (for example, the acidity and alkalinity of waters, oxidation and reduction conditions, and so forth).

The secondary elements are most of the chemical elements of the periodic system. Their average content in the earth's crust is very low, often as low as 1.10^{-3} to 1.10^{-7} per cent or less. Therefore these elements do not determine the physical and chemical conditions of the environment; their migration depends rather on the situation created by the principal elements. It is clear that the taxonomic significance of the principal elements for the geochemical classification of landscapes is far greater than that of the secondary elements.

4. Abiogenous and biogenous landscapes.

We attach the greatest taxonomic significance to those forms of motion of matter that are related to the migration of atoms in the landscape. From that point of view we can distinguish a series of landscapes in which only mechanical, physical and chemical migrations take place. Those are the

landscapes of eternal snows, bare rocks and some volcanoes.

In most of the landscapes the mechanical, physical and chemical processes are accompanied by complex biological (biogeochemical) phenomena that also determine the geochemical characteristics of such landscapes. We call the first series of landscapes abiogenous and the second biogenous. These will be the largest units of the geochemical landscape classification scheme. (The notion of a fundamental difference between these two series of landscapes (or types of physical-geographic environment, types of terrain, etc.) has long been accepted in physical geography and has been repeatedly stated in the work of A. A. Grigor'yev, A. D. Gozhev and other geographers. Here we add the geochemical justification for such a subdivision.) Below we will be concerned only with biogenous landscapes. (The lesser diversification of abiogenous landscapes and the simpler character of the chemical reactions taking place in such landscapes greatly simplify the geochemical classification of these landscapes.)

5. The biological circulation of atoms.

A characteristic feature of biogenous landscapes is the biological circulation of atoms, consisting of two opposite processes -- the creation and destruction of organic matter. As a result of the biological circulation, living organisms (plants, animals, micro-organisms) accumulate in the landscape, soils are formed, the earth's crust is weathered, and the chemical composition of surface and ground waters is formed (A. I. Perel'man, 1955).

As we noted above, the main source of energy of chemical processes in the landscape is solar energy, but it acts predominantly through the biological circulation, in which that energy is freed in a form capable of doing chemical work in the process of mineralization of organic matter. We can say therefore that the main geochemical characteristics of a biogenous landscape are created as a result of the biological circulation of atoms, i.e., by the aggregate of living organisms, which V. I. Vernadskiy called living matter. This principle of geochemistry was first formulated for the earth's crust as a whole (including landscapes) by V. I. Vernadskiy; later it was specified and developed further by B. B. Polynov for application to landscapes. The formation of tundra, tayga, steppe and other landscape types depends on how the biological circulation takes place, how much organic matter is formed in the landscape, what its composition is and at what rate it becomes decomposed. It is therefore quite natural that the characteristics of the biological circulation should furnish the basis for a geochemical classification of biogenous landscapes.

6. Main groups, types and subtypes of biological circulation.

We can distinguish aerial and water migrants among the chemical elements that take an active part in the biological circulation. The former include C, H, O, N and a few other elements. They are the building blocks of all organic compounds -- hydrocarbons, proteins, fats and so on; the migration of these elements determines the main geochemical characteristics of biogenous landscapes. The aerial migrants enter living matter mainly from the atmosphere(CO_2 and so forth) and after the death of the organisms return to a large degree to the atmosphere. They are usually in a gaseous

state, although they also migrate in the form of ions and molecules in water solutions.

The basic types of landscapes distinguished in physical geography are characterized by sharply different conditions of circulation of the aerial migrants, particularly the three main migrants -- O, C and H (mainly in the form of CO_2, H_2O and O_2). For example,the tundra is marked by a large amount of H_2O, an extreme lack of O_2 in the soil, and a low intensity of CO_2 circulation.

In the desert, on the other hand, there is a great deal of O_2, a lack of H_2O and, consequently, also a weak intensity of CO_2 circulation. In the humid tropics CO_2 migrates very intensively. All this makes it possible to use the characteristics of circulation of the aerial migrants as the basis for subdividing the series of biogenous landscapes into smaller taxonomic units -- groups, types and, possibly, subtypes. (The notion of types of biological circulation of elements was first worked out by V. R. Vil'yams in 1936. He distinguished three basic types characterized by various processes of formation and destruction of organic matter in the soil. In the present paper we take account of the ideas of that outstanding scientist, although we start from somewhat different principles.)

We have distinguished four groups of landscapes characterized by sharply different biological circulations of aerial migrants:

I. Forest landscapes.
II. Meadow and steppe landscapes.
III. Tundra landscapes
IV. Primitive desert landscapes.

Forest landscapes (Group I) are marked by a very considerable accumulation of the total mass of living matter (i.e., chiefly C, O, H), greatly exceeding its annual output. A forest landscape reaches a mature state in about a dozen years, during which the annual accumulation of living matter ranges from a few tons to dozens of tons per hectare (in terms of dry organic matter). The total mass of living matter amounts to hundreds and thousands of tons per hectare. The mineralization of organic matter proceeds in two phases: annually, as a result of the dying off of the falling leaves, and other organic residue, and over longer periods of time, when the main mass of vegetative matter (tree stumps and so forth) dies off. As a result, a large part of the chemical elements (especially C, Ca, Mg, P and others) are long excluded from the biological circulation because they "linger" in the bodies of organisms. In these landscapes the process of biological circulation of many elements thus lasts dozens, and sometimes even hundreds and thousands of years. Because of the accumulation of a large mass of living matter, organisms have an especially large influence on the landscape. Specifically, under the panoply of the trees of the forest a special microclimate is created and the composition of the atmosphere changes (higher content of CO_2 and water vapor, and a large amount of flying organic substances, such as

phytocides). In these landscapes, the greater part of the living matter is usually found above the surface of the ground (the mass of tree trunks and leaves greatly exceeding the mass of the roots). Landscapes of Group I display very clearly the ability of organisms to create their own habitat; in these landscapes organisms transform the surrounding environment especially intensively. Most of the living matter here consists of highly organized plants -- gymnosperms and angiosperms.

A different type of biological circulation of atoms is found in meadow and steppe landscapes (Group II), which lack especially large "reserves" of living matter, whose total mass does not exceed 30 to 40 tons per hectare, i.e., tens and hundreds of times less than in forest landscapes. The annual output of living matter is still quite considerable and in many cases is just as large as in landscapes of Group I. In many Group II landscapes, for example, steppes, most of the living matter that is annually produced dies off. The chemical elements therefore "linger" relatively briefly in living organisms; they leave the organisms promptly to take part in the next cycle of the biological circulation. For most of the atoms, therefore, the biological circulation here is not so drawn out, lasting one year or several years. Organisms play a more limited role in forming their own habitat or in creating a special micro-climate. Most of the living matter is in many cases found below the surface of the soil (the mass of the roots exceeding the mass of the plant organs above the surface). Group II includes steppes, meadows and some desert landscapes. These landscapes contain highly organized plants, mainly angiosperms.

Typical of Group III landscapes is a small total mass of living matter and a small amount of annual output; far fewer atoms are drawn into biological circulation here than in Groups I and II, i.e., the circulation is of low intensity. Among living organisms as important role is played by simply organized plants, such as mosses, lichens and algae, although there are also some highly organized plants. The ability of plants to improve their habitat is in many cases very limited. The landscapes in this group are the tundras, moss bogs and a few others.

Finally, Group IV includes landscapes in which the biological circulation is effected mainly by lower plants -- algae, bacteria, lichens. The total mass of living matter is extremely small, the organisms penetrate only slightly into the lithosphere (the vertical extent of the landscape is small), and the total effect of the geochemical activity of organisms is much lower than in Groups I, II and III. The landscapes in Group IV are the clay deserts, salt marshes, and lichen-covered rocks. We call them primitive desert landscapes.

The above breakdown is preliminary and does not rule out that further analysis of the problem and accumulation of new geochemical data may help define additional groups and somewhat change their boundaries.

But even within the groups the biological circulation of aerial migrants

proceeds in different ways. For example, humid tropical forests are characterized by a very large mass of living matter, a rapid rate of growth, and a rapid decomposition of organic residue, while northern forest (tayga) landscapes are characterized by a smaller total mass of living matter and a slower rate of growth and decomposition. Similarly in Group II the circulation in steppes differs from that in meadows. Therefore we can distinguish landscape types within the groups depending on the characteristics of the biological circulation of aerial migrants (mainly C, O, H). The subdivision into types is based on the annual output of living matter and the rates of growth and decomposition. However the geochemical criteria for distinguishing types require further refinement. In this connection considerable help may be found in the experience accumulated by geobotany in the classification of the plant cover.

It has long been established that each family, genus and species of plants has a specific chemical composition. The biological circulation of atoms in each plant is quite distinctive, and each species constitutes a separate cyclical chemical reaction. Therefore the types, classes, formations, associations and other units of the plant cover distinguished in geobotany (the humid tropical forest, laurel-type forest, deciduous forest of the temperate zone, tayga, upland swamp and so forth) are characterized not only by a specific plant composition, a certain number of tiers, closeness of formation and other geobotanical indices, but also by definite geochemical properties, such as amount of living matter, rate of growth and of decomposition, and a definite element composition, i.e., a distinctive biological circulation of atoms.

In other words, the plant-cover types distinguished in geobotany are distinct types of biological circulation of aerial migrants and of chemical reactions taking place in landscapes.

Therefore a geobotanical classification of the plant cover and a geochemical classification of landscapes can coincide in some particulars since both schemes classify essentially different aspects of very similar objects.

About a dozen landscape types can be distinguished on the basis of the characteristics of the biological circulation. For example, the group of forest landscapes includes the humid tropics, tayga landscapes, forest landscapes of the temperate zone, and so forth. Group II landscapes include the chernozem steppes, subtropical steppes, alpine meadows and so forth. (While there is no doubt that these basic plant-cover types distinguished in geobotany differ quite sharply in geochemical characteristics, we still lack sufficient criteria of a purely geochemical character to distinguish landscape types. We regard turning "for help" to geobotany as a temporary measure.)

It should be noted that many landscape characteristics important in a geochemical classification may not be significant in a geobotanical classification. Therefore geochemical landscape types will not always

coincide with vegetation landscape types. For example, the effect of permafrost on the biological circulation of atoms is so great as to enable us to distinguish a separate type of permafrost-tayga landscape although geobotanists do not distinguish a special forest type in the permafrost zone. It is possible that on the basis of the characteristics of biological circulation of aerial migrants the landscape types can be further subdivided into subtypes corresponding to zonal subtypes of the plant cover and soils (northern, middle and southern tayga, mixed forest; mixed herbaceous-grassy steppes; grassy steppes; grassy wormwood steppes and so forth).

7. Geographical distribution of landscape groups and types.

The biological circulation of aerial migrants depends basically on the climate since the climate determines the amount of precipitation and, to a considerable degree, the intensity of photo-synthesis and decomposition of organic matter (i.e., the C and O circulation). The distribution of landscape groups and types over the earth's surface is therefore subordinated to the law of climatic zonality. Geochemistry simply provides an additional basis for the law of landscape zonality established by V. V. Dokuchayev. We know that all subsequent research merely confirmed and deepened his brilliant concepts, whose importance for geography can be compared with that of Mendeleyev's periodic system for chemistry.

It seems to us that the preceding statement also applies directly to physical-geographic regionalization and that from the geochemical point of view the landscape zone is a major taxonomic unit in the regionalization of countries. (Geochemical analysis merely strengthens the regionalization principles followed by many physical geographers. We do not rule out the delimitation of larger regional units than the zone that would include all landscapes forming part of a group. From that point of view we could distinguish, for example, a desert and steppe belt, a forest belt, and so forth.)

8. Water migrants and the delimitation of landscape classes.

Within types (and possibly subtypes) the greatest differences between landscapes are related to water migrants (Ca, Na, Cl and others) rather than aerial migrants. Water migrants migrate in natural waters and greatly affect biological circulation, mineral formation and other processes. The gaseous form of migration is not typical of these elements, and they occur more rarely in organisms than the aerial migrants.

Therefore the subdivision of landscape types (and subtypes) into classes is based on the typomorphic elements and ions of water migration. These are elements and ions that migrate intensively with natural waters accumulated in the landscape and determine its geochemical characteristics within a type, including the characteristics of biological circulation (A. I. Perel'man, 1955).

Landscapes differ substantially depending on the composition of typomorphic elements. For example, within the tayga type there is a clear distinction between the acid ($H^{\cdot}$), calcium ($Ca^{\cdot\cdot}$) and acid gley ($H\text{-}\tilde{F}e^{\cdot\cdot}$)

classes. The waters within landscapes of the first class are acid (H being the typomorphic ion); their active migrants include calcium, magnesium, cobalt, copper, and phosphorus. Therefore the soils are poor in these elements and of low fertility. Domestic animals in such landscapes suffer from a lack of calcium and are affected by rickets; plants also lack many nutrients. In $Ca^{\cdot\cdot}$- class landscapes, usually formed on limestone or basalt, the waters are rich in calcium, their reaction is neutral or slightly alkaline, the soils are more fertile and domestic animals do not suffer from a lack of $Ca^{\cdot\cdot}$ and have a normal bone structure. In landscapes of the acid gley class, ground and surface waters have an acid reaction; a reducing medium predominates; iron and manganese are active migrants, and the waters contain many organic colloids. A lack of free oxygen in the water leads to an accumulation in the landscape of dead, half-decomposed organic residue in the form of peat. The biological circulation is therefore greatly slowed, and the productivity of the landscape is low. This class includes the water-logged tayga.

Although every type contains several landscape classes, one class usually predominates. For example, in the tayga type it is the acid ($H^{\cdot}$) class, in the tundra and permafrost tayga types the acid gley ($H^{\cdot}$-$Fe^{\cdot\cdot}$) class, in the chernozem steppe the calcium class, and so forth. But the tundra type, in addition to the dominant $H^{\cdot}$-$F^{\cdot\cdot}$ class, also contains $Ca^{\cdot\cdot}$-class landscapes (on limestones) and $Na^{\cdot}$-class landscapes (on coastal saltwater marshes). The humid tropics type, in addition to the dominant $H^{\cdot}$-class, also contains landscapes of the $H^{\cdot}$-$Fe^{\cdot\cdot}$ class (swampy forests), the $Na^{\cdot}$-class (coastal mangrove forests), the $Ca^{\cdot\cdot}$-class (on limestones), and so forth.

The total number of geochemical landscape classes is not very large; the most common landscapes fall into six or seven basic classes (see Table on Page 72).

Thus, from a taxonomic point of view the class is below the type; for example, the coastal saltwater tundra is part of the tundra type, desert salt marshes are part of the desert type, and tropical salt marshes (mangroves) are part of the humid tropics type.

If we assumed that the class was higher than the type and that consequently the migration of water migrants was more important than that of aerial migrants, we would have to combine acid tayga and humid tropical landscapes ($H^{\cdot}$-type), saltwater tundra, deserts and mangrove swamps ($Na^{\cdot}$ type), and tundra, tayga and humid tropics on limestones ($Ca^{\cdot\cdot}$-type). There is no need to demonstrate the falseness of such a classification.

The formation of landscape classes depends on various factors: climatic conditions, geological structure, land forms, proximity to the sea (influx of salts) and so forth. Geological structure and land forms are usually the basic factors. Therefore the geographical distribution of landscape classes is usually not in accord with zonality, but rather with tectonics and other azonal factors.

Basic Geochemical Landscape Classes

Landscape types based on biological circulation of aerial migrants	Landscape classes based on typomorphic elements of water migration					
	$Ca^{\cdot\cdot}$	$H^{\cdot}$	$H^{\cdot}$	$H^{\cdot}$-$SO4^{\cdot\cdot}$	$H^{\cdot}$-$Fe^{\cdot\cdot}$	$Na^{\cdot}$-$Cl^{\cdot}$ $SO4^{\cdot\cdot}$
Tundra	tundra on limestone	"dry" mountain tundra	no data	tundra landscape on sulphide rocks	lowland tundra on non-limestone rocks (*)	saltwater tundra
Tayga	tayga on limestone	tayga on non-limestone rocks (*)	tayga on quartz sands	tayga on sulphide rocks	swampy tayga	no data
Steppe	steppe on nonsalinified rocks (*)	absent	absent	steppe on sulphide rocks	absent	salt-marsh steppe
Humid tropics	humid tropics on limestone	humid tropics on non-limestone rocks(*)	humid tropics on quartz sands	humid tropics on sulphide rocks	swampy forest of the humid tropics	mangrove landscape

(*) Predominant class

It follows that in physical-geographic regionalization lower-order regional units within zones (and possibly subzones) are best delimited on the basis of geological structure and land forms. By giving geological structure priority over zonality in regionalization, we place class above type in landscape classification.

Geochemical principles can also be used in delimiting even smaller taxonomic units -- landscape families, genera, species, and so forth, but that problem cannot be discussed in the present paper.

The state of the problem of classification usually reflects the general level of development of a science. Landscape is still being studied only to a limited extent as a distinct natural body and therefore we still lack a detailed landscape classification. We must establish the specific properties and qualities of landscapes and determine their taxonomic significance. Only on such a firm basis can be built a classification of landscapes. In this paper we have tried to show the contribution that the geochemical method can make. Further research in that direction is essential.

SOME PROBLEMS OF ELECTRIC POWER DEVELOPMENT IN THE KUYBYSHEV ECONOMIC ADMINISTRATIVE REGION

By P. N. Stepanov and Yu. N. Savenko

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The Kuybyshev economic administrative region has become one of the main industrial regions of the Soviet Union with an important oil industry, chemicals, machine building, electric power and building industry.

The industry of Kuybyshev Oblast continues to expand at a rapid rate. The 1958 production level of major commodities compared with 1955 was as follows: crude oil production 2.2 times higher, electric power generation 4.3 times, ballbearings production 39 per cent. Labor productivity in industry increased by 22 per cent in that period.

The total volume of capital investments in construction and reconstruction of industrial plants during the seven-year plan (1959-65) is planned at more than 32 billion old rubles. It is proposed to complete and start production at 33 new large industrial plants and to rebuild many existing enterprises. The gross output of industry under the Kuybyshev regional economic council is expected to increase by 2.5 times by 1965 compared with 1958, while the planned increase of output of industry under the oblast authorities is set at 1.7 times the 1958 level.(Editor's note, S.G.: Under the industrial management system introduced in 1957, major industries fall under the jurisdiction of the regional economic councils and industries of local importance

under the jurisdiction of the oblast authorities.) The production of the machine-building industry is expected to increase by 2.4 times during the seven-year period, crude oil production by 2.5 times, natural-gas production by 3.3 times, chemical production by more than 14 times. Such increases, exceeding the average nationwide rates of growth envisaged by the seven-year plan, are predicated on further increases in labor productivity, which is expected to increase in the oblast by almost 80 per cent in industry and by 60-65 per cent in construction during the seven-year plan.

Energy production is closely linked to the economic development of the country as a whole and of its regions. Energy production, and particularly its leading element, the production of electric energy, is a major branch of heavy industry. The forerunning development of electric power production is an essential condition for expanded Socialist reproduction.

In 1958 Kuybyshev Oblast produced six times as much electric power as Tsarist Russia produced in 1913. (Editor's note, S. G.: Russian power output in 1913 was about 2 billion kilowatt-hours.) A large part of the Kuybyshev power output is transmitted to the Central Industrial Region and to the Urals.

A large share of the electric power generated in Kuybyshev Oblast is consumed by the industrial sector. According to 1958 data, more than 50 per cent of the power consumed in Kuybyshev Oblast was consumed by industry, about 10 per cent by municipal enterprises, 8 per cent by the construction industry, 5 per cent by transportation and 2 per cent by agriculture. In the industrial sector the principal consumers were the machine-building industry (30 per cent of the total industrial consumption), the oil industry (30 per cent) and the chemical industry.

The economic development of Kuybyshev Oblast under the seven-year plan envisages an increase of power consumption by 2 to 2.5 times. Since the contemplated increase in power generation during the seven-year period is only 32 per cent, it means that long-distance power transmission to other regions will be reduced by 1965 to 62 per cent of the 1958 level.

(Editor's note, S. G.: The percentage relationships make it possible to calculate the approximate power generation statistics for Kuybyshev Oblast. Total power generation would increase from about 12 billion kilowatt-hours in 1958 to about 16 billion by 1965; in-oblast consumption would increase from 6 million in 1958 to 12 million by 1965, while out-of-oblast transmission would drop from 6 million in 1958 to 4 million by 1965.)

In connection with the contemplated rate of growth of industrial production in the Kuybyshev economic administrative region and the program of mechanization and automation of production, several measures are required to improve the electric-power indices of the oblast. The principal measures are: construction of electrical distribution systems and halting of the construction of small power plants supplying the needs of only one small plant or industry;

integrated expansion of steam, gas and electric-power supply for the whole economic region with centralized control and a common plan of development for the entire region.

The principal power stations of the oblast are the following five: the Volga Hydroelectric Station named for V. I. Lenin (2.3 million kilowatts), the Bezymyannaya TETs (teploelektrotsentral' -- central steam-electric station,at Kuybyshev, Novokuybyshevsk TETs, Kuybyshev GRES (gosudarstvennaya rayonnaya elektricheskaya stantsiya -- state regional electric station) and the Syzran' TETs. The total installed capacity of these five stations accounts for 95 per cent of the total power-generating capacity of the oblast. In 1958 these stations produced 98 per cent of the oblast's total power output.

The Volga hydro station, which reached its full installed capacity at the end of 1957, is by far the most important element of the Kuybyshev power system. (It accounts for about 9 billion kilowatt-hours of the oblast's total annual power output of 12 billion -- Editor, S. G.) Before 1956 the Kuybyshev power system operated in isolation from the country's other power systems. The start of generation at the Volga hydro plant and the construction of 400,000-volt transmission lines to Moscow (1956) and to the Urals (1958) changed not only the capacity of the Kuybyshev system but its importance as a national power supply source. It now links the power systems of the Urals and Central European Russia and plays a major role in the contemplated link-up of the power systems of the entire Middle Volga valley.

Interconnections between the electrical systems of distant economic regions make it possible to make better use of the country's potential power resources, to reduce the total generating capacity needed because the maximum demand for power in separate systems does not occur at the same time, and to improve greatly the utilization of power capacities.

The organization in Kuybyshev of a combined load-dispatching center for all Volga electrical systems would constitute a major step forward in the construction of a single electrical system for the Soviet Union as a whole.

Because of the Volga hydro plant, hydroelectric generating capacity greatly predominates in Kuybyshev Oblast. Out of the total generating capacity of the oblast, 80 per cent is hydroelectric and 20 per cent thermal. In 1958 the hydroelectric station accounted for 75 per cent of the total power output of the oblast. It fills about 40 per cent of the oblast's power consumption on the average. (This apparently means that the oblast power needs, estimated at 6 billion kilowatt-hours, are filled about 40 per cent by the hydro plant and about 60 per cent by thermal plants. Of the hydro plant's total annual output of 9 billion kilowatt-hours, more than 6 billion are apparently transmitted out of the oblast and less than 3 billion are consumed locally -- Editor, S. G.)

An inadequate transmission capacity of substations and lines is greatly limiting the operating potentialities of the Volga hydro plant. A matter of high

priority would seem to be the conversion of the transformers of the Volga hydro station from 400,000 to 500,000 volts, which would result in a 25 to 30 per cent increase in the capacity of the transmission lines to Moscow and to the Urals and enable the hydro station to produce an additional 600 million kilowatt-hours in time of flood.

One of the pressing problems in the organization of the oblast's power system is rationalization of the fuel supply of the major thermal stations. At the present time these stations use Karaganda coal, Donbas coal dust, fuel oil, natural gas and, in the case of the Syzran' TETs, oil shale. Despite an increase in the use of local fuels, such as high-sulphur fuel oil, natural gas and the oil shale of the Kashpir deposit (at Syzran'), up to 83.6 per cent of the total fuel needs (according to 1958 data), the optimum fuel structure has not been reached yet.

In particular, the Bezymyannaya TETs is now largely fueled with natural gas piped from the Mukhanovo-Otradnyy oil and gas producing area (east of Kuybyshev). There is a proposal to reduce gas transmission to the Bezymyannaya TETs and convert the station to coal while increasing the gas supply for the Kuybyshev GRES, now fueled mainly with Karaganda and Donbas coal. The Kuybyshev GRES is having problems with its coal supply. Karaganda coal, for example, is shipped by rail to Syzran' and then from Syzran' to Kuybyshev by the Volga River. This greatly increases the cost of the coal, which is 106 to 110 old rubles per ton, since a large part is made up of transportation expenses. Since coal reaches the station only during the navigation season, the station must accumulate large reserves. The storage of large amounts of coal in the open air results in a deterioration of the quality of the coal. The location of the Kuybyshev GRES in the heart of the city also results in serious air pollution. That is why the station should be converted to gas. In this connection the Bezymyannaya TETs would be converted from gas to coal. However, it should be noted that the location of the Bezymyannaya station in the Kirov Rayon, one of the largest rayons of Kuybyshev city, with a population of 200,000, also requires anti-pollution measures.

The Syzran' TETs occupies a special place in the problem of fuel supply for the oblast's major thermal stations. Its main fuel at present is the oil shale of the Kashpir deposit. In addition to being used as fuel for the Syzran' station, oil shale is also sent to the shale refinery near Syzran'. The shale-mining operations are uneconomical. The mining costs of the shale are far higher than the shale's price of 25 old rubles a ton. In addition it should be pointed out that the shale sent for burning at the thermal station has a higher chemical content than the shale sent for distilling to the refinery.

The burning of shale at the Syzran' TETs also creates bad sanitary conditions at the boiler station. This situation must be changed if the shale is to be used rationally. The shale must be utilized in a really complex fashion as is done in Estonia. Such complex utilization would greatly increase the economic efficiency of the Kashpir mine. (In addition to being used as a

power-station fuel, Estonia's oil shale is processed to yield gas for long-distance transmission to Leningrad and Tallinn, gasoline, fuel oil, asphalt, cinder blocks and a host of other products -- Editor, S. G.)

In addition to the major regional stations, the Kuybyshev economic administrative region is also served by many small power plants. These plants do not play an important role in the power generation of the oblast as a whole and therefore insufficient attention is being devoted to ways of improving their operations.

The construction of small industrial, municipal and rural power stations relates to the following factors: (1) inability to supply power from the regional system because of a shortage of generating capacity and transmission lines; (2) the need for supplying mechanical power, electricity and steam heat to many small, scattered consumers (oil wells, oil exploration parties, agriculture, small towns, settlements and industrial plants); (3) the lack of an integrated approach to a solution of the power-supply problem of the oblast.

With few exceptions the small power stations are operated by the consumers themselves. This results in underutilization of installed capacity, problems in connection with repairs, supply of fuel and training of personnel and an inadequate use of modern operating methods, mechanization or automation of the main production processes at the small stations.

The lack of concern for integrated planning of the oblast's electric-power industry and a bureaucratic approach to that problem has led to an excessive increase in the number of small stations with low operating efficiency and an extreme diversity of types.

The agriculture of Kuybyshev Oblast receives about 60 per cent of its electric power from small rural stations with a total installed capacity of about 20,000 kilowatts (average capacity per generator -- 40 to 50 kilowatts), producing about 30 million kilowatt-hours a year. These rural installations are not used more than 1,500 hours a year. Electricity is available to nearly all state farms, of which there are 66 in the oblast, all machine-tractor and tractor-repair stations and about 185 collective farms (about 35 to 40 per cent of the total number of collective farms in the oblast -- Editor, S. G.).

The degree of electrification of agriculture in the oblast is still far from adequate. This is explained, first, by the low stage of development of power transmission lines and, second, by the fact that most of the farms have their own generators, which are inadequate for broad electrification of production, especially power-consuming processes.

It has been calculated that the density of the rural generating capacity in Kuybyshev Oblast is on the average 2.0 to 3.5 kilowatts per square kilometer. For such a high load density it would be far more efficient to

distribute electric power from a central dispatching point over high-voltage lines. In this case substations along electrified railroad lines could be used to supply electric power to consumers situated within 100 to 150 km. of the railroad. Further construction of small industrial, municipal and rural power plants should therefore be sharply restricted.

At the present time only six rayon seats (out of about 35 -- Editor, S.G.) are fed by the Kuybyshev regional system, the others relying on small generators. In the current seven-year plan all rayon seats are to be linked to the regional system, and a large rural electrification program is expected to add 16,500 km. of transmission lines and about 4,000 consumer substations. This program will make it possible to supply power to a large number of rural rayons.

Other seven-year plan goals call for nearly doubling the length of the transmission lines in the Kuybyshev regional system and for a fivefold increase in the capacity of the voltage-reduction substations. The electrification of the main line of the Kuybyshev Railroad was expected to be completed in 1960, requiring about 50 km. of new transmission lines and 21 substations. About 700 km. of 35,000 and 110,000-volt lines are to be erected for electrification of the oil fields.

In addition to priority development of a centralized power-supply system, serious attention should also be given to the use of economical types of small power stations in certain areas of Kuybyshev Oblast having a load density of up to 1-1.5 kilowatts per square kilometer . Thus far local power systems have been developed without regard for the possibility of cooperation among adjoining consumers. This has lead to a great overexpenditure of funds. Small factories and farms often encounter difficulties in the repair of electrical equipment, especially transformers, apparatus and direct-current motors and generators. In eliminating these shortcomings greater use should be made of the advantages that have opened up since the industrial management reform (of 1957, in which the management of most of Soviet industry was transferred from central ministries to regional economic councils -- Editor, S. G.). The regional economic councils should be charged with responsibility for rural electrification.

The integrated development of the electric-power system of the Kuybyshev economic administrative region is only the first step in the realization of the advantages offered by the new system of industrial management. Further efforts in that direction should lead to coordinated planning of electrical systems of adjoining economic administrative regions.

Integrated planning will make possible radical improvement of the use of the fuel and energy resources of economic regions, more effective use of energy resources (local types of fuel, secondary energy resources) and the realization of several measures of an organizational character, such as the establishment of consumption norms, the organization of repairs and the training of personnel.

The need for integrated development of the power systems of economic regions also requires improved planning methods. In addition to the electric power estimates that are generally drawn up by local planners, they should also draw up fuel estimates and over-all energy estimates typing together all major components, such as fuels, electric power and steam heat. Insufficient concern with over-all energy planning is slowing work on the fixing of rational power-consumption norms in various industries. Existing norms are to a large extent experimental, or are entirely lacking in some industries. This leads to an overconsumption of energy, especially for industrial purposes. The problem of working out rational power-consumption norms should be given careful attention. The letter of the party's Central Committee on rational utilization of electrical energy in the national economy (1959) should furnish the basis for establishing such norms and controlling their application.

As the power industry of Kuybyshev Oblast grows and expands, it is making greater demands on the power machine-building industry and the system of specialization and subcontracting.

The oblast is now building large new thermal stations (Stavropol' and Novokuybyshevsk No. 2), greatly expanding the Syzran' TETs (a fourfold increase in capacity), planning the construction of thermal stations at Chapayevsk and Isakly, building and rebuilding small and medium factory stations, and expanding the transmission grid. The growth of the electric power system requires considerable deliveries of power equipment, transformers, various types of electrical apparatus, construction steel, building materials and the organization of repair facilities. There is also need for proper organization of scientific research and the training of power-station personnel. The Kuybyshev regional economic council has done some work in that direction. It has established several scientific research laboratories. However, they often work without coordination among themselves and without relation to the current needs of the oblast economy.

In the light of the decisions of the 21st party congress (which approved the seven-year plan) and the plenary meeting of the party's Central Committee in June 1959 (regarding the modernization of industry), the party units and economic and public organizations of the Kuybyshev economic administrative region are doing a great deal to fulfill the goals of the seven-year plan, making maximum use of the advantages of the new system of industrial management. As part of that effort, attention should also be given to the problem of integrated planning of the regional power system.

NEWS NOTES

By Theodore Shabad

Kazakh Economic Regions Shifted. In connection with the establishment of the Tselinnyy (Virgin Lands) Kray in Kazakhstan (see Soviet Geography, February 1961, p. 75), the Tselinnyy Kray has been established as a separate administrative economic region within which all industry and construction are managed by the Tselinnyy regional economic council with headquarters at Akmolinsk, capital of the Kray. The Kustanay administrative economic region, equivalent to Kustanay Oblast, and the North Kazakhstan administrative economic region, which included North Kazakhstan and Kokchetav oblasts, have been abolished. The management of the major industrial and construction activities of former Akmolinsk Oblast and of Pavlodar Oblast have been transferred from the Karaganda regional economic council to the Tselinnyy council. Kazakhstan is now divided into eight administrative economic regions: Tselinnyy (Virgin Lands), Karaganda, East Kazakhstan, Semipalatinsk, Alma-Ata (including Alma-Ata and Dzhambul oblasts), South Kazakhstan (including South Kazakhstan and Kzyl-Orda oblasts), Aktyubinsk (including Aktyubinsk and North Kazakhstan oblasts) and Gur'yev. All are under the jurisdiction of an over-all Kazakh economic council (Kazakhstanskaya Pravda, December 30, 1960).

Voroshilovsk Retains Name. The city of Voroshilovsk (formerly Alchevsk) in the Donets Basin of the Ukraine had been expected to revert to its former name in accordance with a Soviet decree of 1957 barring the naming of places for living personalities. As of January 1, 1961, Voroshilovsk still retained its name, the only major holdout in the wave of renamings that followed the 1957 decree.

New Oil and Gas Lines. An oil pipeline opened in December 1960 between Ishimbay and Orsk (Pravda, December 18, 1960). The line carries crude oil from the Bashkir fields to the Orsk refinery. The Orsk refinery, built in the mid-1930's, originally processed Baku crude oil transported by tanker across the Caspian to the Gur'yev terminal and then by pipeline to Orsk. As output at the Emba fields near Gur'yev increased, Emba crude oil was sent by pipeline to Orsk. Now, with the shift of the main crude-oil production to the Volga-Urals and a shortage of refinery capacity there, Orsk serves mainly the new fields of the Bashkir and Tatar republics.

A 767-km. gas pipeline from the Bukhara gas fields to Tashkent was completed in January 1961 (Pravda, January 5, 1961). The pipeline originates in the Dzharkak field, 50 km. southeast of Bukhara, and parallels the Bukhara-Samarkand-Tashkent railroad. Natural gas will supply fuel or raw material to thermal power plants at Navoi (until 1958 called Kermine) and Tashkent, a nitrogen fertilizer plant at Navoi, cement plants at Navoi and Akhangaran. The pipeline is being extended to Chimkent in southern Kazakhstan, and will ultimately go on to Alma-Ata, Karaganda, Kustanay and the Urals.

The alignment has been fixed for a pair of pipelines going directly from the Bukhara fields to the Urals (Pravda Vostoka, December 1, 1960). The two pipelines will originate at the Gazli field, 70 km. northwest of Bukhara, and run through Khiva, west of the Aral Sea and through Chelkar and Orsk. One pipeline, to be built by 1963 and 1,800 km. long, will terminate at Chelyabinsk. The other, to be built by 1965, will continue 300 km. farther to Sverdlovsk. The pipelines will have a diameter of 1020 mm.

Irkutsk Aluminum Plant Opens. The electric smelting department of the Irkutsk aluminum plant, situated at Shelekhov, southwest of Irkutsk, opened in December 1960 (Izvestiya, December 31, 1960). It utilizes sillimanite, an aluminum silicate, to produce aluminum-silicon alloys. The sillimanite, mined near Kyakhta, is concentrated at Zakamensk (until 1959 called Gorodok). Work is continuing on the electrolytic departments of the Irkutsk plant, which is ultimately expected to use alumina from the nephelite-processing plant at Achinsk.

Ukrainian Titanium Mines. The establishment of new workers' settlements -- Irshansk, Granitnoye and Chervonogranitnoye -- in August 1960 in the area of the upper Irsha River between Volodarsk-Volynskiy and Malin (Zhitomir Oblast), according to Vedomosti Verkhovnogo Soveta SSSR draws attention to the ilmenite-titanium placer mines previously reported in the Irsha River area (Pravda Ukrainy, March 14, 1958; July 4, 1958). Some of the workers' settlements may also, as their names indicate, be associated with granite quarries. In addition to the Irsha ilmenite placers, the Ukraine is also obtaining titanium, in association with zirconium, from the Samotkan' River, a right affluent of the Dnieper River, near Verkhne-Dneprovsk, Dnepropetrovsk Oblast (Izvestiya, December 18, 1957). Both titanium and zirconium have become important metals in recent years in the aircraft, missile and electronics industries.

Electric Power Developments. A 220,000-volt transmission line has been completed, linking the shale-fueled Baltic thermal power station at Narva (Estonia) with Leningrad, 170 km. away (Sovetskaya Estoniya, December 10, 1960). By the end of 1960, the Baltic power plant had an installed capacity of 300,000 kilowatts, to be doubled by the end of 1961. The ultimate capacity is now planned at 1,625,000 kilowatts.

The 21st 105,000-kw. unit was installed in the Stalingrad hydroelectric station in December 1960, bringing the total installed capacity to 2,415,000 kw. (Sovetskaya Litva, December 9, 1960). The installation of an experimental turbine will bring the total capacity to 2,563,000 kw. It is the largest hydroelectric station pending completion of the Bratsk station on the Angara River in Siberia, planned at 4,500,000 kw.

The first 200,000-kw. unit went into operation in January 1961 at the Zmiyev-Komsomol'skoye thermal power station, on the Donets River south of Khar'kov in the Ukraine (Ekonomicheskaya Gazeta, January 18,1961). It is fueled with natural gas from the nearby Shebelinka field and will provide power for industries of the Khar'kov area, including a large cement plant under construction near by at Balakleya.

Krivoy Rog Iron Mines. A third concentrator processing low-grade Krivoy Rog iron ore began operations in 1960 (Pravda, December 31,1960). It is the South No. 2 concentrator, which converts iron quartzites with a metal content of 35 to 40 per cent into blast-furnace-grade concentrate with an iron content of 60 to 63 per cent. Two other concentrators -- the South No. 1 (opened in 1955) and the Novo-Krivoy Rog (opened in 1959) -- were already in operation under a major program to utilize the low-grade ores of the Krivoy Rog iron district. Three more concentrators -- the Central, Northern and Ingulets plants -- are to be built.

The large water requirements of the iron-ore concentrators will be met by a canal from the Kakhovka reservoir on the Dnieper River. The canal, which opened in December 1960 (Pravda Ukrainy, December 10, 1960), is 42 km. long, 25 to 32 meters wide and 3.5 meters deep. It terminates in a 50-million cubic-meter reservoir south of Krivoy Rog.

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